AMATEUR ROBOTICS • BASIC STAMP • COMPUTER CONTROL • ELECTRONIC COMPASS

Nuts & Volts

April 2000
Vol. 21 No. 4

Exploring Electronics And Technology For A New Millennium

Seven new devices to simplify your Computer Controlled World.

www.nutsvolts.com

An electronic compass that's easy to build and outperforms the old-fashioned magnetic types.

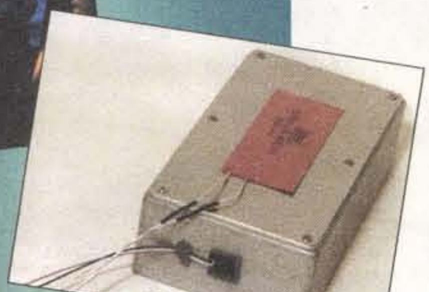
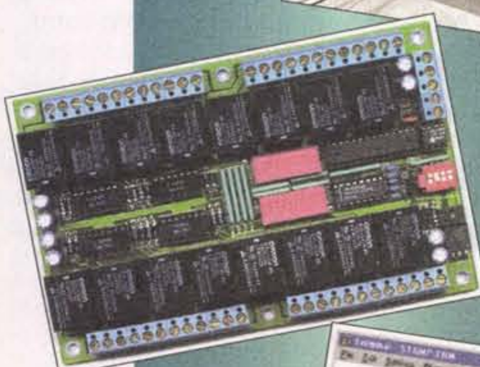
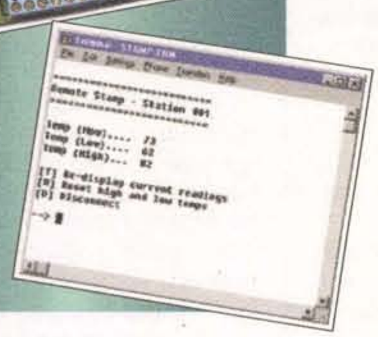
Tune in on a militia group or pirate broadcast station with a shortwave receiver that you can build yourself.

U.S. $4.50 CANADA $6.50
04>
7 25274 89295 2

VOLUME 21 • NO. 4
APRIL 2000

Contents



Classified Ad Index

Departments

COLUMNS

NUTS & VOLTS (ISSN 1065-2035) IS PUBLISHED MONTHLY FOR $19.00 PER YEAR BY T & L PUBLICATIONS, INC., 430 PRINCELAND COURT, CORONA, CA 92879. APPLICATION TO MAIL AT PERIODICALS POSTAGE RATES IS PENDING AT CORONA, CA AND AT ADDITIONAL MAILING OFFICES. POSTMASTER: SEND ADDRESS CHANGES TO NUTS & VOLTS MAGAZINE, 430 PRINCELAND COURT, CORONA, CA 92879-1300.

BUILD AN ELECTRONIC COMPASS

SOLID-STATE CIRCUIT · CONTAINS NO MOVING PARTS

by Anthony J. Caristi

Just about every one of us has fooled around with that ubiquitous device we call a compass. It's relatively simple, consisting of a magnetized pointer or needle balanced and suspended on a pivot. The pointer – influenced by the earth's magnetic field – is free to rotate and when it comes to rest, it points to the magnetic north pole. Although even the most inexpensive compasses really work, they leave a lot to be desired. Friction between the pointer and pivot may impair operation, they need to be held perfectly horizontal for reliable operation, and it takes some time for the pointer to come to rest at a point that we hope is true magnetic north.

The magnetic north pole of the earth is actually located in the Northwest Territories of Canada. Because of this, a magnetic compass will not point to true geographical north unless it is located near an imaginary line that stretches from the Alabama Gulf to Lake Superior. This line is identified as "zero degrees" in Figure 1.

For all other locations, one must take into account the offset – called magnetic declination – which can be as much as ±20 degrees in the United States. The map in Figure 1 can be used to determine the amount of magnetic declination for all parts of the continental United States.

Modern electronics technology has provided the means to construct a solid-state compass containing no moving parts, thus avoiding mechanical problems. The electronic compass described here is extremely easy to build, and will easily outperform the old fashioned magnetic types. It utilizes a device called a linear Hall-Effect generator which produces an electrical output that is proportional to the intensity of the magnetic field passing through the semiconductor material.

Since this compass contains no moving parts, it is extremely rugged and can tolerate virtually any kind of stresses that might be encountered when traveling in rough or mountainous terrain. It is easy to use, and will provide a quick and reliable reading. Power to operate the circuit is provided by a common nine-volt transistor radio battery that will allow many hours of intermittent operation.

HOW IT WORKS

Refer to Figure 2. A Hall-Effect sensor consists of a small sheet of semiconductor material through which a bias current flows. Its output voltage – measured perpendicularly to the flow of current – is a function of the intensity of magnetic lines of force that pass through the chip in the direction depicted in the illustration.

Depending upon the actual direction of the magnetic field and its intensity, the output voltage of the sensor will be somewhat above or below the quiescent value that exists when the sensor is not subject to magnetic influence. Typical sensitivity of many Hall-Effect sensors may be in the order of two millivolts per Gauss. Since the earth's magnetic field is about one-half Gauss, it can be seen that as the sensor is rotated 360 degrees, its output voltage may vary over a range of ± one millivolt.

Unfortunately, Hall-Effect sensors are not very temperature stable, and the output voltage will not be an absolute number. This problem has been solved by Analog Devices Corporation using instrumentation technology to reduce temperature effects. Their AD22151 magnetic field sensor utilizes a pair of Hall-Effect devices that are fed to a differential amplifier. The two amplified Hall-Effect signals are synchronously demodulated using built-in circuitry, and the result is a temperature compensated, low offset output voltage that is proportional to the intensity and direction of the external magnetic field.

ABOUT THE CIRCUIT

Refer to the schematic diagram. Nine-volt battery power is applied to U1, a fixed five-volt linear regulator. The use of a regulator is required to maintain circuit stability as the terminal voltage of the battery decreases with use. A spring loaded switch applies voltage to the circuit so that once a reading is taken, the power will automatically disconnect when the user releases the switch.

U2 is a surface mount linear output magnetic field sensor that produces an output voltage which is proportional to a magnetic field that is applied perpendicularly to the top surface of the package.

The chip contains a built-in op-amp that utilizes external resistors (R2 and R3) to set the gain of the device. Using the values shown in the schematic, the sensitivity of U2 is about 1.3 millivolts per Gauss. U3 is a combination op-amp and comparator chip that is used to amplify the output voltage of the magnetic sensor, and detect when it exceeds a certain value as set by potentiometer R7.

U3A is the op-amp section of the chip and has a gain of 470 as determined by R4 and R5. It has a large value of capacitance across the feedback resistor to filter out any AC signals generated by the demodulator in the magnetic sensor. The op-amp output voltage at pin 1 is fed to the positive input of comparator U3B, pin 5. Potentiometer R7 is set during calibration so that the voltage at the wiper is somewhere between the maximum and minimum output voltage at pin 1 of U3A as the compass is rotated a full 360 degrees.

Thus, it can be seen that the output voltage of the comparator at pin 7 will be high when the compass is facing magnetic north, and low when it is facing 180 degrees away from magnetic north. When R7 is properly set, the high level output of U3B will represent a smaller rotational arc (such as 90 degrees or less) than that for U3B low level output.

When the comparator output is high, Q1 is forward biased, illuminating LED1. In use, the compass is rotated to identify the arc at which the LED is illuminated. Then, the North Pole indicator is positioned at the center of the arc. The scale of the compass will then indicate all compass directions.

CONSTRUCTION

The compass is constructed on a small single-sided printed circuit board measuring about 3/4 by 2-1/4 inches. This allows it to be installed vertically in a small, square enclosure less than one inch high. The circuit is not critical, and may be wired on a perfboard, if desired. If you do not wish to etch and drill your own board, one may be purchased from the source listed in the parts list. Figure 3 illustrates the printed layout, shown in full size as seen from the copper side of the board.

The enclosure will also contain the nine-volt battery and the on/off push-button switch. At final assembly, LED1 will be mounted to the top surface of the enclosure, at the north indicator of the scale (Figure 7).

Figure 4 illustrates the parts placement. The first components that should be assembled to the board are U2 and U3. These are surface mount components that must be properly soldered in place, with a low wattage soldering iron, that has a pointed tip. As indicated in the printed layout of Figure 3, pin 1 of each IC pattern is represented by a dot. Figure 5 shows how to identify the corresponding pin #1 of each of these two parts. Use the following procedure to solder the chips to the board:

1. Gently clean the board with a scouring pad to remove oxidation and any other contaminants. Rinse well in cold water and dry thoroughly.

2. An assistant will be helpful with this and the next step. Place the IC directly over the copper pattern, observing where pin 1 of the chip is. Some ICs have a small dot that indicates pin 1. Others indicate pin 1 by the legend that identifies the part number. See Figure 5.

3. While holding the chip in place, solder only one corner pin to the board being careful not to use excessive heat or solder. Too much heat will cause the copper pad to lift off the board. Excessive solder may result in a short circuit between two adjacent pins.

4. Examine the location of all pins of the chip with respect to the copper pattern. All pins must lie directly over the pads. If not, adjust the chip's position or remove the IC and repeat steps 2 and 3.

5. If you are satisfied that all pins are properly positioned, solder the remaining seven in place. When finished, examine the connections to be sure they are solid with no solder bridges between pins.

Insert the remaining components into the board as illustrated in Figure 4, using Figure 6 to identify the connections of the terminal connections of Q1 and U1. Pay strict attention to the orientation of these parts and the electrolytic capacitor, which are polarized. Double check before soldering — any polarized component placed backwards in the circuit will cause an inoperative compass and possible damage to one or more of the parts.

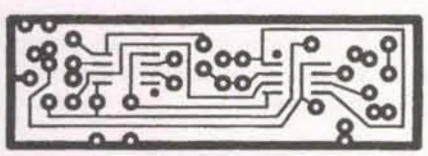
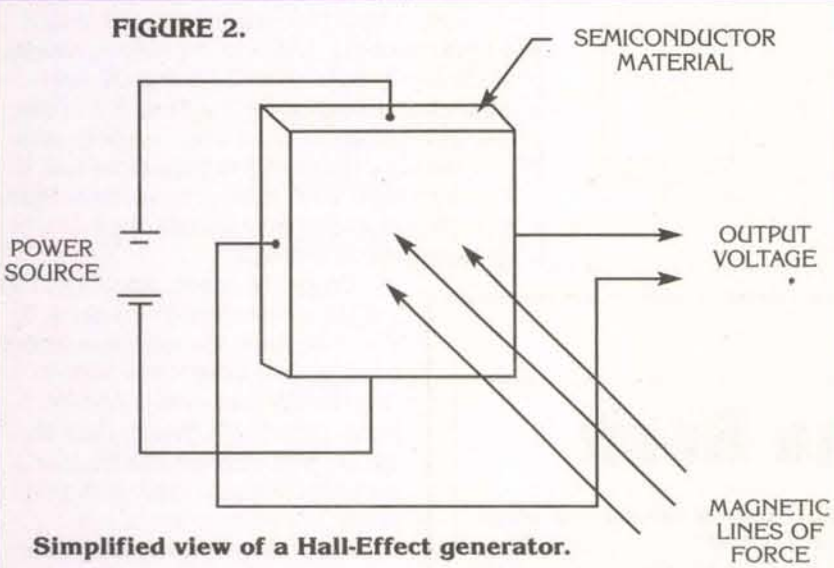


FIGURE 3.

Printed layout shown full size as seen from the copper side of the board.

FIGURE 2.



Simplified view of a Hall-Effect generator.

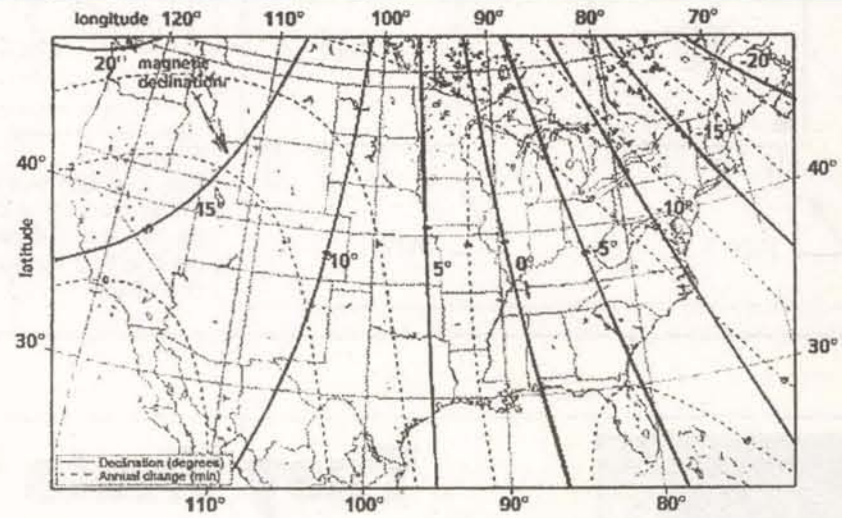
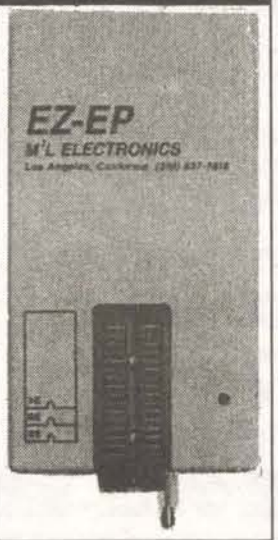


FIGURE 1. Positive value of magnetic declination indicate that True North lies west of the magnetic North Pole. Negative values indicate that True North lies east of magnetic north.



The board requires one jumper wire, identified as J1 in Figure 4, to complete the circuit. This wire connects U2 and U3 pin 4 to circuit common. The LED may be temporarily soldered to the board, as indicated in the schematic diagram, for the preliminary test. Be sure to observe polarity of this component, which can be determined by using an ohmmeter that is set to one of the higher Ohms scales.

When finished stuffing the board, check for inadvertent short circuits and bad solder connections. Any connection which is not shiny and smooth is suspect and should be redone by removing the old solder with braid, cleaning the joint, and applying new solder. Correct any problems now before proceeding.

BATTERY CONNECTOR

Nine-volt battery clips are readily available from electronics parts suppliers, but one is easily fabricated by taking apart an old battery and removing the connector. It is best to solder a red and black flexible wire to the rear side of the connector, observing proper polarity which will be opposite to that of a battery. Be sure to check connector wiring by clipping on a fresh battery and verifying with a DC voltmeter that the red wire is positive and the black wire is negative.

Once the polarity of the connector wiring has been verified, remove the battery and temporarily solder the two wires to the board at the +9 volt and common circuit connections as indicated in Figure 4 and the schematic diagram. When finished, set the board aside while preparing the enclosure.

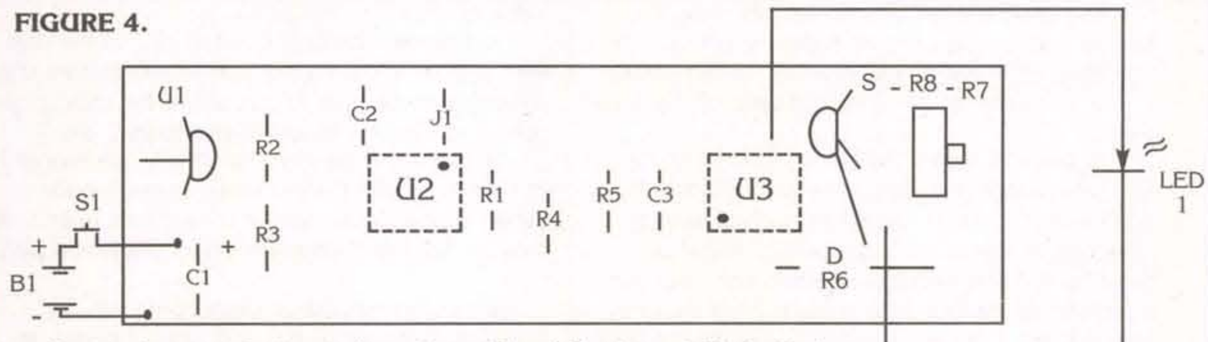
ENCLOSURE

Select a suitable enclosure – plastic and not metal – that is about 2-1/2 inches square so that it will accommodate the scale illustrated in Figure 7. Make a photocopy, lay it on the top side of the enclosure, and mark the location of the LED which should be on the north pointer of the scale. Drill a suitably-sized hole in the enclosure for the LED.

Place the PC board in a vertical position inside the enclosure, against the side that will correspond with the location of the LED and north pole indicator of the scale. U2 and U3 should be facing the outside, and potentiometer R7 should be on the right as seen from the top. Note the location of potentiometer R7, and drill a hole in the side of the enclosure that will permit a small screwdriver to be used for calibration. Determine a suitable location for the on/off switch, and drill a hole for that component.

Proceed to the preliminary checkout before permanently mounting the board and other parts to the enclosure.

FIGURE 4.



Parts placement shown from top side of the board. Note that U2 and U3 are placed on the opposite side.

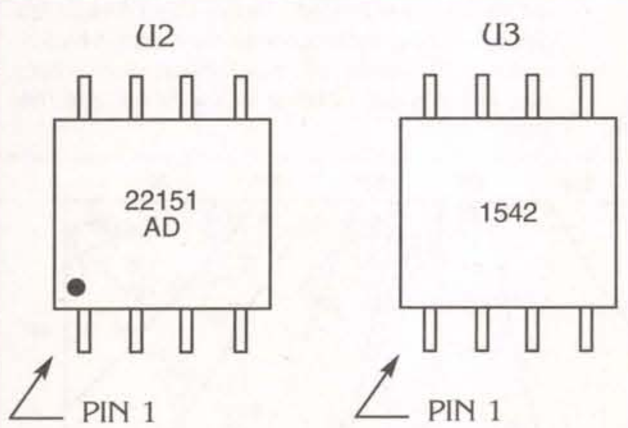


FIGURE 5.
Pin 1 of U2 and U3 is identified by a dot, or by the legend printed on the top surface of the chip.

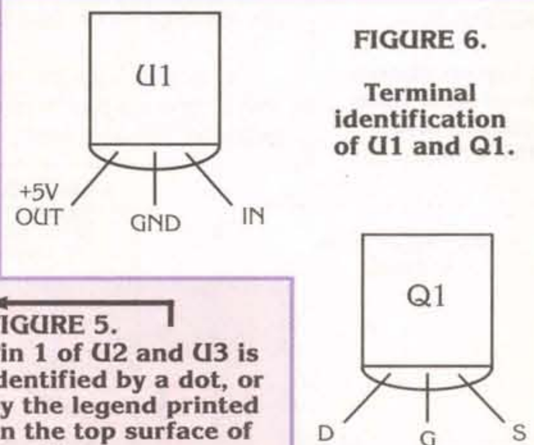


FIGURE 6.
Terminal identification of U1 and Q1.

PRELIMINARY CHECKOUT

Take a fresh nine-volt battery and snap it on the connector. Measure the output voltage of the regulator (across C2) with a DC voltmeter. Normal indication is 4.75 to 5.25 volts. If you do not obtain the correct reading, measure the battery terminal voltage to be sure it is at least eight volts. If so, remove the battery from the circuit and troubleshoot the board to locate and repair the fault.

Check the orientation of U1, U2, and U3 as illustrated in Figures 4, 5, and 6. Measure the resistance across C2 to be sure there is no short circuit. Normal indication is 2.5K or more. Try a new regulator chip. Do not proceed with the checkout until the fault has been repaired and U1 delivers five volts to the circuit.

Continuing with the test, measure the voltage at pin 1 of U2. Normal indication is 2.5 to 4.5 volts. Rotate R7 over its range and verify that the LED will be lit at one part of the rotation, and extinguished for the remainder.

Hold the board in the vertical plane so that the long dimension is horizontal with the surface mounted components facing away from you, just as it would be when mounted in the enclosure. Turn your body so that the surface mounted components face north, and carefully adjust R7 so that the LED just comes on. Allow time for the long time constant of the amplifier to stabilize.

Now turn yourself and the board around slowly and note that the LED will be off when the chips on the board face south, and on when they face north. This completes the preliminary checkout.

FIGURE 7.

Use a photocopy of this artwork for the scale. Glue it in place on the top of the enclosure.

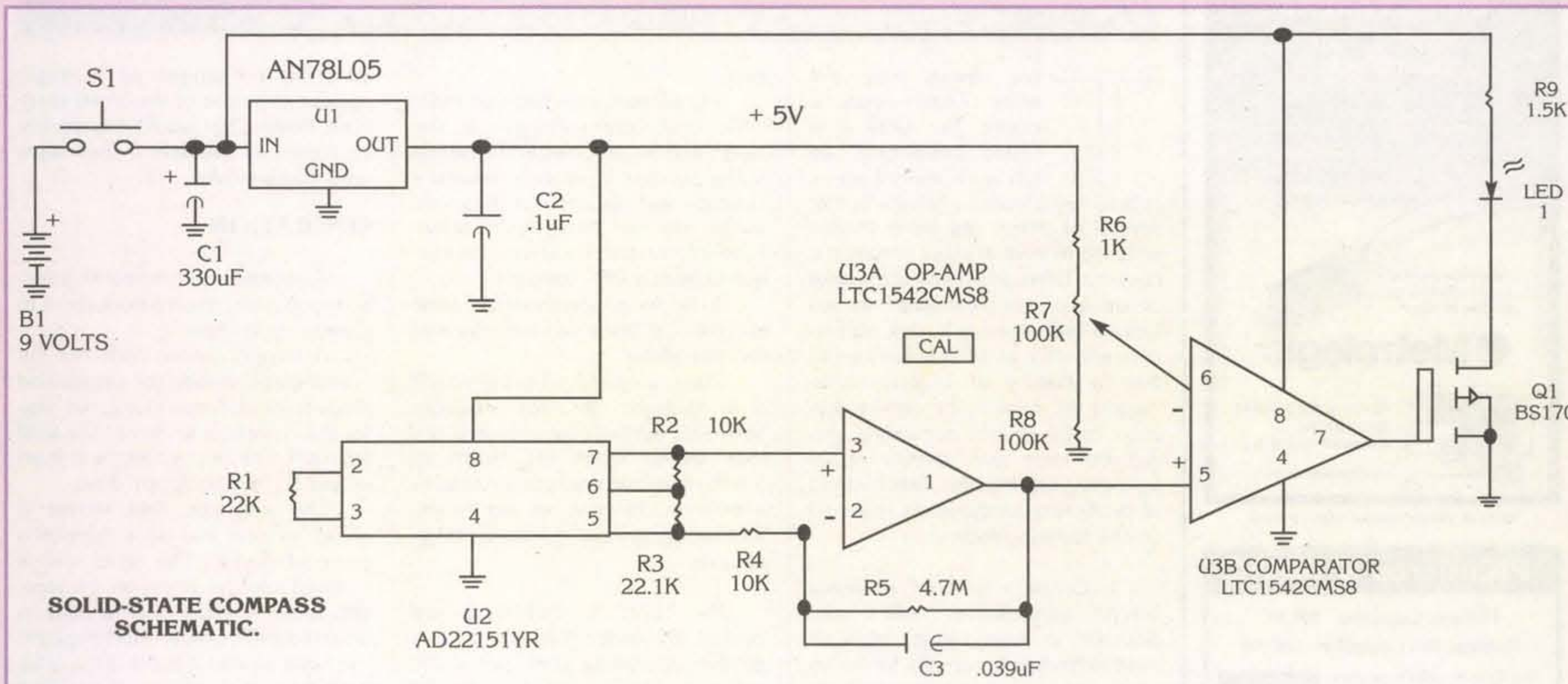
FINAL ASSEMBLY

The LED may be removed from the board and mounted to the top of the enclosure through a hole, using RTV silicone rubber. After the adhesive has cured, a pair of small gauge flexible wires may be soldered to the LED. Use two different colors and check the polarity of the connections with an ohmmeter so that the wires will be properly connected to the circuit.

The easiest way to mount the PC board to the side of the enclosure is to use a small amount of RTV silicone rubber, but the builder has the option of using any other method that he or she finds suitable. The board must be mounted in the vertical plane against the side of the enclosure that corresponds to the LED and north indicator of the scale, with the surface mounted components facing to the outside. Mount the on/off switch, and hold the power switch. Rotate the compass very slowly in a horizontal circle and note the arc at which the LED is lit. Carefully adjust R7 with a small screwdriver so that the arc is as small as possible when facing magnetic north, consistent with a solid lighting of the LED. An arc of 45 degrees is ideal.

Note the position of the compass as the LED comes on from the left and from the right. True magnetic north will be that position of the compass when the LED is placed at the center of its lighted arc. Use the information in Figure 1 to offset the compass for the number of degrees that correspond with your location.

Once the compass is oriented to that position, all directions will be indicated by the scale. **NV**



SOLID-STATE COMPASS SCHEMATIC.

Note: The values of R6 and R8 may optionally be tailored to center the adjustment range of R7 for the particular U2 chip used in the circuit.

TROUBLESHOOTING

If you do not obtain the results described above, remove power from the board and visually check for opens, shorts, and bad solder connections. Refer to Figure 4 and the schematic diagram and check that all components are the correct values and placed in their respective locations. Verify that U2 and U3 are oriented properly. Check the polarity of the LED. If necessary, try a new LED.

wire it and the battery connector in accordance with the schematic diagram. Be sure to observe proper polarity. Secure all wiring away from the magnetic sensor.

FINAL ADJUSTMENT

Final adjustment of R7 should be made outdoors, away from buildings or metal structures which may distort the earth's magnetic field. Insert a fresh battery into the connector and put the cover in place. Hold the enclosure horizontally with the LED positioned away from you, press and

PARTS LIST

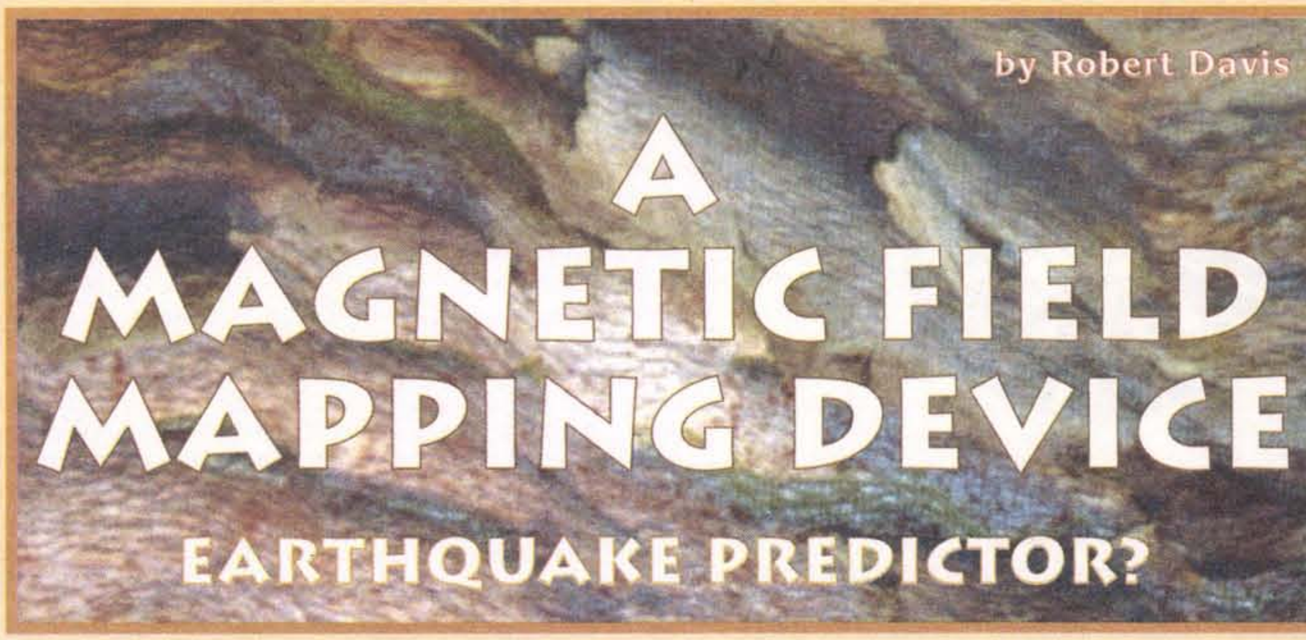
B1: 9-volt alkaline transistor radio battery
C1: 330 uFd 10-volt radial electrolytic capacitor
C2: 0.1 uFd 50-volt ceramic disc capacitor
C3: 0.039 uFd 50-volt ceramic disc capacitor
R1: 22K 1/4-watt carbon resistor
R2: 10K 1/4-watt 1% metal film resistor
R3: 22.1K 1/4-watt 1% metal film resistor
R4: 10K 1/4-watt carbon resistor
R5: 4.7 Megohm 1/4-watt carbon resistor
R6: 1K 1/4-watt 1% metal film resistor
R7: 100K cermet pot, PC mount, Digi-Key 3306K-104-ND or similar
R8: 100K 1/4-watt 1% metal film resistor
R9: 1.5K 1/4-watt carbon resistor
LED1: High-efficiency light emitting diode, Digi-Key 1700QT-ND or similar
Q1: N channel MOSFET, BS170 or similar
U1: 5-volt linear regulator, AN78L05 (Digi-Key)
U2: Magnetic sensor, Analog Devices AD22151YR (Future Electronics)
U3: Op-amp/comparator, Linear Technology LTC1542CS8-ND (Digi-Key)
S1: Push-button switch, Digi-Key 150C-ND or similar
Misc: Enclosure, battery clip, hook-up wire

SOURCES OF SUPPLY

Digi-Key: 1-800-344-4536

Future Electronics (AD22151YR): 1-800-333-9943

Note: The following parts are available from A. Caristi, 69 White Pond Road, Waldwick, NJ 07463: Etched and drilled PC board @ $9.95, U1 @ $2.00, U2 @ $9.75, U3 @ $6.75, set of four metal film resistors @ $2.00, Q1 @ $3.00. Please add $5.00 postage/handling.



by Robert Davis

A MAGNETIC FIELD MAPPING DEVICE

EARTHQUAKE PREDICTOR?

This device may not work. Then again, it might. But until it is tested thoroughly, we will not know if it works or how well it works. My hope is that several of these can be built and installed in several cities across the country. Then, when an earthquake occurs in one of those cities, we will know if this device will work properly or not work at all. If it does work, then a history of various earthquakes will have to be collected in order to be able to accurately predict the time and severity of an upcoming earthquake. This method of predicting earthquakes is based on the following facts.

1. Contrary to what scientists teach, earthquakes ARE predictable. In every case, animals have behaved abnormally for hours to days before an earthquake. In Kobo, Japan, the zoo animals were acting so strange that the zoo keepers took it as an omen that something terrible was about to happen. In other cases, dogs have barked wildly, or pets have simply run away in mass.

Scientists attribute this behavior of animals to what they call "micro tremors." These are believed to be earthquake tremors so small no instrument can measure them, but somehow animals can still detect them.

2. Animals are sensitive to, and can even navigate by, magnetic fields. Stories of long lost animals finding their way home abound. Cats and dogs have found their way back home from thousands of miles away, sometimes from the other side of the country.

In an attempt to understand this ability of animals to find their way, scientists studied sea turtles. They can return to the same beach where they were born 30 years later. How do they find that beach? Scientists discovered that baby sea turtles, when placed in a pool, swam exactly East to West. When a magnet is placed near the pool, they will swim around the magnetic field.

It is a little known fact that magnetic fields are strongest at the North and South poles and weakest at the equator. If you can sense the strength and direction of magnetic fields, you can navigate by them. (The information on animal navigation is from a PBS special.)

3. Magnetic abnormalities exist around fault lines and the edges of tectonic plates.

These are believed to be "fixed" and thought to not change. Scientists attribute them to iron ore that settled when the North to South magnetic field was pointed in a different direction, or before the tectonic plate rotated from its original axis.

My belief is that they are caused by rocks like quartz that produce electricity when put under pressure. This electricity, when it flows through minerals and water, produces a magnetic field. This field aligns iron ore, etc., to match the abnormal field. Quartz only produces brief currents when the pressure on it changes so it might appear as pulses of abnormal magnetic fields. That would explain the confusion of animals if they navigate magnetically.

OPERATION

To operate, the sensor is pointed North, then rotated from down to East to up to West.

A stepper motor performs the operation of rotating the sensor and stops several times along the way for the computer to record the field strength. The stepper motor is from an old 5-1/4 inch floppy drive.

The magnetic field sensor is glued on one end of a three-inch piece of plastic. The other end is screwed into the wheel on the stepper motor's shaft. The sensor is powered from positive and negative five volts so that if there is no magnetic field, the output will be close to zero volts. The regulators must be fairly accurate so the output will stay close to zero volts.

Magnetic field strength is measured using a 12-bit analog-to-digi-

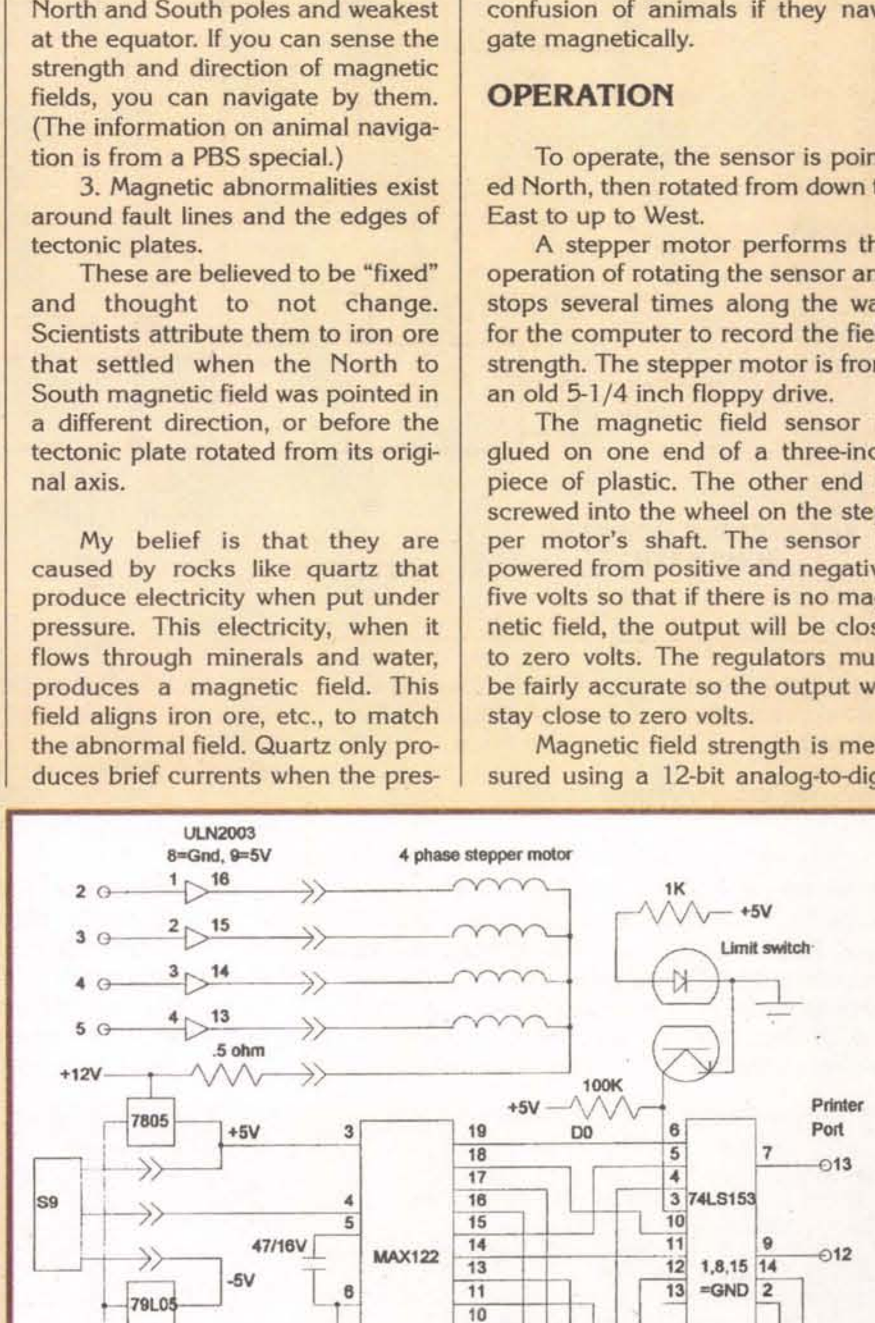


FIGURE 1: SCHEMATIC OF THE CIRCUIT.

Below is the latest update to the software. It now can run automatically every hour and save the results to the hard drive. This program works well on an IBM 486 Thinkpad. The screen and hard drive shut off so only the CPU keeps running. Make sure the CPU does not go into "suspend" mode or the program will not run except for the very first time.

Another improvement is to add three 2.2K resistors from the printer port pins 1, 14, and 17 to the regulated five-volt power supply. This change will reduce noise when you are using a longer printer cable.

Also not mentioned in the schematic or text is the color code for the used Teac stepper motor. The Brown lead is the 12-volt power source. The color of the four wires for the phases are from top to bottom yellow, red, blue, and white.

I don't remember if I mentioned it in the text but the variable "waittime" must be set according to the processor speed. If it is too small, the motor won't move. If it is too large, the stepper doesn't move smoothly.

```
CLS : PRINT "Magnetic Field Mapper, Copyright 1999 By Robert J Davis"
PRINT "Output readings are in milligauss use maximum-minimum / 2"
INPUT "Use Printer Port Nunber: ", LPT
dout = &H378: cout = &H37A: cin = &H379
IF LPT = 1 THEN dout = &H3BC: cout = &H3BE: cin = &H3BD
IF LPT = 3 THEN dout = &H278: cout = &H27A: cin = &H279
mhour$ = MID$(TIME$, 1, 2)
DIM mfield(99)

start:
hour$ = MID$(TIME$, 1, 2)
IF hour$ = mhour$ AND cycle = 1 THEN GOTO start
cycle = cycle + 1
IF cycle > 2 THEN cycle = 0
mhour$ = hour$

max1 = -999: max2 = -999 'use for negative numbers
max3 = -999: max4 = -999 'use for negative numbers
min1 = 0: min2 = 0: min3 = 0: min4 = 0
waittime = 42       '486 - 25 speed
Findstop:
OUT cout, 0
FOR b = 0 TO 3
  OUT dout, 2 ^ b
  IF (INP(cin) \ 16) MOD 2 = 1 THEN GOTO getforward
  FOR A = 1 TO waittime: NEXT A
NEXT b
GOTO Findstop

getforward:
FOR c = 1 TO 16

getinput1:
OUT cout, 8
OUT cout, 3: value1 = (INP(cin) XOR &H80) \ 16
OUT cout, 2: value2 = (INP(cin) XOR &H80) \ 16
OUT cout, 1: value3 = (INP(cin) XOR &H80) \ 16
tvalue1 = value1 + (16 * value2) + (256 * value3)
IF tvalue1 > 2048 THEN tvalue1 = tvalue1 - 4096
LOCATE c + 3, 1: PRINT tvalue1
IF max1 < tvalue1 THEN max1 = tvalue1
IF min1 > tvalue1 THEN min1 = tvalue1
mfield(c) = tvalue1

getinput3:
OUT cout, 8
OUT cout, 3: value1 = (INP(cin) XOR &H80) \ 16
OUT cout, 2: value2 = (INP(cin) XOR &H80) \ 16
OUT cout, 1: value3 = (INP(cin) XOR &H80) \ 16
tvalue3 = value1 + (16 * value2) + (256 * value3)
IF tvalue3 > 2048 THEN tvalue3 = tvalue3 - 4096
LOCATE c + 3, 20: PRINT tvalue3
IF max3 < tvalue3 THEN max3 = tvalue3
IF min3 > tvalue3 THEN min3 = tvalue3
mfield(c + 40) = tvalue3

counterclockwise:
FOR d = 1 TO 3
  FOR b = 3 TO 0 STEP -1
   OUT dout, 2 ^ b
   FOR A = 1 TO waittime: NEXT A
  NEXT b
NEXT d
NEXT c

getreverse:
FOR c = 1 TO 16

clockwise:
FOR d = 1 TO 3
  FOR b = 0 TO 3
   OUT dout, 2 ^ b
   FOR A = 1 TO waittime: NEXT A
  NEXT b
NEXT d

getinput2:
OUT cout, 8
OUT cout, 3: value1 = (INP(cin) XOR &H80) \ 16
OUT cout, 2: value2 = (INP(cin) XOR &H80) \ 16
OUT cout, 1: value3 = (INP(cin) XOR &H80) \ 16
tvalue2 = value1 + (16 * value2) + (256 * value3)
IF tvalue2 > 2048 THEN tvalue2 = tvalue2 - 4096
LOCATE 20 - c, 10: PRINT tvalue2
IF max2 < tvalue2 THEN max2 = tvalue2
IF min2 > tvalue2 THEN min2 = tvalue2
mfield(c + 20) = tvalue2

getinput4:
OUT cout, 8
OUT cout, 3: value1 = (INP(cin) XOR &H80) \ 16
OUT cout, 2: value2 = (INP(cin) XOR &H80) \ 16
OUT cout, 1: value3 = (INP(cin) XOR &H80) \ 16
tvalue4 = value1 + (16 * value2) + (256 * value3)
IF tvalue4 > 2048 THEN tvalue4 = tvalue4 - 4096
LOCATE 20 - c, 30: PRINT tvalue4
IF max4 < tvalue4 THEN max4 = tvalue4
IF min4 > tvalue4 THEN min4 = tvalue4
mfield(c + 60) = tvalue4
NEXT c

Park:
FOR d = 1 TO 27
  FOR b = 3 TO 0 STEP -1
   OUT dout, 2 ^ b
   FOR A = 1 TO waittime: NEXT A
  NEXT b
NEXT d
OUT dout, 0  'shut off stepper

display:
LOCATE 9, 40: PRINT "Scan1 Scan2 Scan3 Scan4 Average"
LOCATE 10, 40: PRINT max1 - min1
LOCATE 10, 46: PRINT max2 - min2
LOCATE 10, 52: PRINT max3 - min3
LOCATE 10, 58: PRINT max4 - min4
LOCATE 10, 64: PRINT (max1 - min1 + max2 - min2 + max3 - min3 +
   max4 - min4)
/ 4
Save:
mfile$ = "c:" + MID$(DATE$, 7, 4) + MID$(DATE$, 1, 2) + MID$(DATE$,
   4, 2)
OPEN mfile$ FOR APPEND AS #1
FOR c = 1 TO 16
PRINT #1, mfield(c);
NEXT c
PRINT #1, " "
FOR c = 21 TO 36
PRINT #1, mfield(c);
NEXT c
PRINT #1, " "
FOR c = 41 TO 56
PRINT #1, mfield(c);
NEXT c
PRINT #1, " "
FOR c = 61 TO 76
PRINT #1, mfield(c);
NEXT c
PRINT #1, " "
PRINT #1, "Range", max1 - min1, max2 - min2, max3 - min3, max4 -
   min4
PRINT #1, TIME$
CLOSE #1

GOTO start
END
```

tal converter. The converter has a range of positive to negative five volts, so it can measure any field the sensor can detect. The sensor is 25 millivolt per Gauss or .025 volts per Gauss. If 2048 is 5 volts and -2048 is -5 volts, then the smallest measurable voltage is 5V/2048 or .0025 volts. If my math is correct, that would then correspond to a field of .1 Gauss.

An optical switch from the track zero stop of an old 5-1/4 inch floppy disk drive is used to sense when the sensor is pointed down. A nail is glued into the slot on the back side of the stepper pointed so that it interrupts the optical switch when the sensor is pointed down.

The program always starts by rotating the sensor and looking for a signal from the optical switch to say that the sensor is in the down position. It then takes a sample of the field strength. Since we are collecting 12 bits, four bits at a time, this will take three, four-bit inputs to get all 12 bits of data. The result is then checked to see if it is a new minimum or maximum field strength and, if it is, it is stored for future reference. After two samples at each position, the sensor is then rotated back for two more samples at each position.

Once a pass is completed, the sensor is parked in the up position, and the final results are tallied and displayed. The difference between the minimum and maximum from each pass is displayed and the average of the four passes is computed. Even then, I run three or four cycles because the results vary with each cycle. Eventually, I hope to add software to automatically run the program every hour for 24 cycles a day.

The software is available for downloading at my web site located at www.elim.edu/tech. The magnetic field mapping device program listing is in Quick Basic.

CONSTRUCTION

Everything is mounted on a piece of plastic about 12 inches by four inches in size. I used some surplus red plastic, but any insulating material would suffice. The stepper motor is mounted with the bracket that held it into the disk drive. Some one-inch metal spacers are used to mount it up higher. The circuit board is mounted with similar spacers. The stop sensor on the back of the stepper motor is glued on.

The magnetic field sensor is a Hall-Effect sensor made by Micro Switch. It is available from Newark Electronics for about $15.00 each. The part number is SS94A1F; it was chosen for its higher sensitivity of 25 mV/Gauss. The Hall-Effect sensor is glued onto the end of the plastic piece of wire mold with the components facing up. The pin connections are from left to right, positive power, output, and negative power. An extra long wire is used to allow room for it to rotate freely.

The power supply is an AC adapter with positive and negative 12 volts outputs. I cut off the connector that came with the adapter and used a binding post to connect it to the circuit board.

A 26-pin header connector is used to connect a ribbon cable about two foot long to a 25-pin male connector that plugs into the printer port of a laptop computer. A desktop computer may not work as well as it will generate magnetic fields that might interfere with the operation of the detector. A solution there might be to use a five-foot, 25-pin extension cable.

Not shown on the schematic, but very necessary for proper operation, are filter capacitors on the inputs and outputs of the voltage regulators. Also filter capacitors are needed on the ICs, especially on the MAX122 analog-to-digital converter's power and ground pins. **NV**

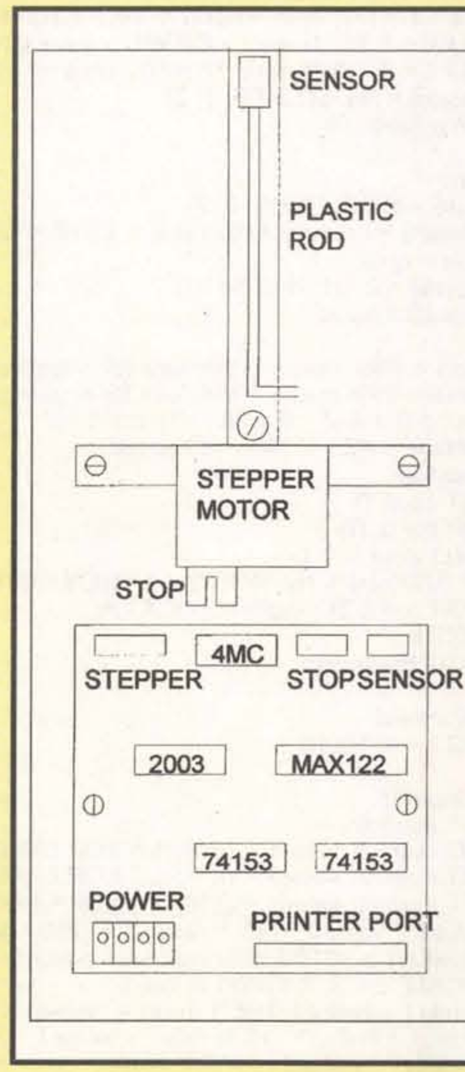


FIGURE 2: PARTS LAYOUT DRAWING.

PARTS LIST

1	SS94A1F Analog position sensor	Newark Electronics
1	MAX122BCNG-ND 12-bit A-to-D converter	Digi-Key
1	4-phase stepper motor	Teac floppy drive
1	Optical switch	Teac floppy drive
1	ULN2003 Darlington driver	Newark, MCM, or Digi-Key
2	74LS153 dual 4-to-1 multiplexer	Newark, MCM, or Digi-Key
1	7805 5-volt regulator	Newark, MCM, or Digi-Key
1	79L05 -5 volt regulator	Newark, MCM, or Digi-Key
1	26-pin header	Newark, MCM, or Digi-Key
1	4MC crystal oscillator	Newark, MCM, or Digi-Key
5	IC sockets	Newark, MCM, or Digi-Key
1	Positive and negative 12-volt AC adapter	Newark, MCM, or Digi-Key
1	26-pin header socket to 25-pin male cable	Newark Electronics
1	3-inch by 3-inch pad per hole circuit board	Newark, MCM, or Digi-Key
	Various resistors and capacitors	Newark, MCM, or Digi-Key

Upgrade Your Existing Laptop Drive FREE details below

Netcom #1 in Customer Service Since 1983

IBM ROAD WARRIOR
Professional Road Equipment

MAXIMUM ABUSE
strictly for professionals

4 Easy payments of $199.99
0% Financing! On Credit Cards only

Blazing Sunlight or Rain
Desert or Snow

> Instant ON
> Drop 3' to Concrete

Rain: (4"/hr Rain w/ 40 MPH *Winds*)
Silicone Rubberized & Diecast Case !
Ultra Shock Mounted 1GIG EIDE Hard Drive !
ESD / EMF & RF Resistant, Works from -4 to 120 Deg F & Vacuum to 15,000 ft

Perfect for GPS Satellite Navigation

Actual Selling Price From IBM ~~$6,912~~

- > 1- PCMCIA (type 1, 2 or 3), Serial & Parallel Ports in rear
- > 16m Ram / 1m Video / **32 Bit** Local Bus 486-50 Mhz Runs 32 bit applications with Ease Math Co-processor, 28.8k Modem (Internet Ready)
- > Very Long Lasting Hydride Battery ($150 Value)
- > Sound & Microphone,
- > 8.25" Display-64 Shade Monochrome REFLECTIVE
- > (Optional) Touch Screen *with* Handwriting Recognition

Rough Service Handle with Loops for optional Shoulder Strap
Roxanne's Voice Annotates Windows 95 Functions

OPTIONS
- > Floppy Drive $89 > 12V Car cord $29
- > Desktop 48X Cd Rom $159
- > Touch Screen $250
- > 33k Baud PCMCIA Fax- Modem Upgrade $35

This was a unique (one shot) purchasing opportunity
IT'S NOT OPEN STOCK
WHEN THEY'RE GONE, THEY'RE GONE FOR GOOD
Sold till recently by IBM through their Local Area Network Div at $4,699 & $6,912 as shown here. (they were never discounted)

Tough!

Sturdy Handle
Rubber Sides

233 Mhz Pentium — Our BEST Selling Computer EVER!

4 Easy payments of Wow $249!
0% Financing! On Credit Cards only

Compare at $1,500
The Traveler
Looks so nice in person, it'll give ya Goose Bumps
Stereo
Ultra Fast

3YR! WARRANTY **FREE Carry Case This month**

Low Price / High Performance

233mhz	**Easy Viewing** High Resolution Razor Sharp & Bright SVGA 8.5" Display 16 Million Color Display Supports High Res modes up to 1024x768 (WOW)
3.2Gig	Comfortable Keyboard with built-in wrist support, Includes **CD & Floppy**
32m ram	Super Built-in **Stereo** Speakers & Mic / Excellent **Touch Pad** Mouse
56k modem	Long life Lithium Ion battery / 2 **USB** ports, IR Port, 2 **PCMCIA** ports
CD 24x	Serial & Parallel Ports / Super Lightweight **3.3 lb** 9.5 x 7 x 1.5
USB (2)	***3 Year Warranty (best in the industry)*** FREE Lifetime NetcomTech support
W98	***OPTIONAL CUSTOM Carrying Case $24*** SOYO Embossed LOGO, Tailored fit, Pockets, Handle & includes Shoulder Strap

SOYO is the leading maker of Computer Motherboards for FAMOUS BRAND NAME computers. The "Traveler" has every "State of the Art" feature you want at a Spectacular price. Runs ANY program with ease. This Ad was created on this machine! Light weight & Ultra portable

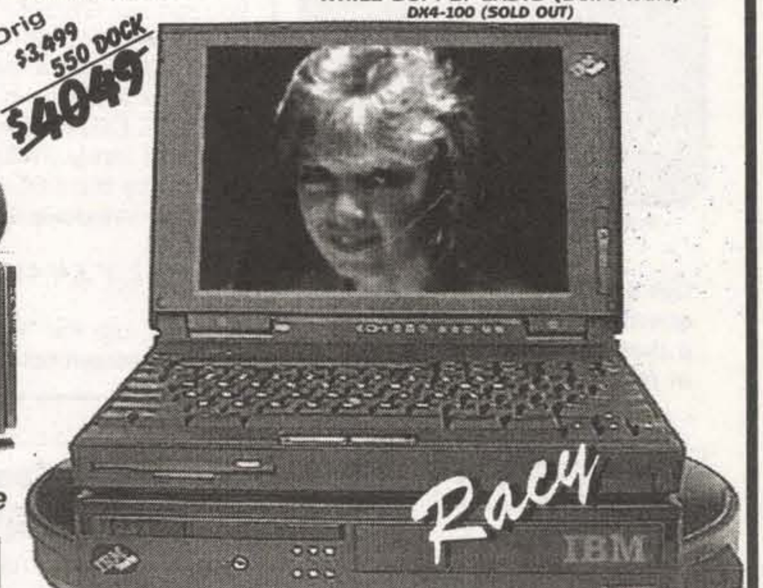
IBM Pentium 75 Works on Space Station

Huge 10.5" ***Active Matrix SVGA Color*** Display
33k FAX MODEM - 2 PCMCIA Expansion Slots
Dual Infrared Ports (Front & Rear)
Track Point Eraser Head Mouse (Very Responsive)
All Standard Ports (1S,1P,1VGA,1Kbd)
Pop out - Hard Drive, Ram, Battery & Floppy.
Ram & Hard Drive Expandable & Upgradable.
Includes Power Supply & Hydride Battery
Free Lifetime Tech Support Web Site Creator Software
Internet Ready, America On Line (Full install)
Fax Modem Software, Searchable Owners Manual s/w, W95
2 Gig Hard Drive 24M Ram

Pentium-75
Wow 0% Financing on Credit Cards only
This Model Survived the Russian Space Station Disaster of -200F to 280F in the Vacuum of Space ! Details in email
4 Easy payments of $215!

INCLUDES DOCK
WHILE SUPPLY LASTS (Don't Wait)
DX4-100 (SOLD OUT)

Orig $3,499 550 DOCK ~~$4049~~



Racy

IBM Docking Stations
From IBM **$550**

This is not just a port expander it's a full blown docking station
You can add ANY desktop ISA card and it will work with your IBM laptop
Imagine the possibilities. Add a TV card and watch TV while you compute !
ISA computer card hides in the base of the unit.

FREE Local Area Network (LAN) card (a $79 value) Notebook Snaps onto the dock.
Expansion Port for optional CD Rom Built-in Speakers Built-in Power Supply & Fan
SCSI Expansion Port / Parallel / Serial / Keyboard / Mouse / Monitor / Stereo in & out
Front panel headphone Jack Hidden Carry handle LED Status Indicators
Color Black (matches notebook) ISA Port cover & Key optional (not required)

2.5"

We CLONE your Existing Laptop Drive FREE
& Create a Perfect Copy on a larger capacity drive

4 Laptop Drive Sizes Available

Drives are Standard 2.5" EIDE for laptops

710 Meg	$75
1 Gig	$119
2 Gig	$149
3 Gig	$199

Your Data Security is Completely Assured
All cloning is done in-house under strict supervision. Original drive is returned with upgraded drive. No files are opened or viewed **at any time**. Period.

Limited Time
IC Master **$29!**
Oh My GOD!

ICM *Bible of the IC Industry Every Cross-reference* 3 Volume Set with Tons of Information

ICMaster Earlier Editions Perfect for Service or Lite Design. Later Editions Perfect for Advanced Design

ICM ~~$195~~ Publisher
- 95 3Book Set $29 !!!!!!!!!!
- 96 3Book Set $49 !!!!!!
- 97 3Book Set $69 !! CD Rom $ 99!!
- 98 3Book gone CD " $129!
- 99 3Book gone CD " $179!

EEM Contains the Complete Catalogs of Most Electronic ~~$119~~ Component Manufacturers & Distributors

EEM
- 97 4 Book Set only on CD $35
- 98 4 Book Set only on CD $55
- 2000 4 Book gone

1 Year Warranty - Satisfaction Guaranteed - The Friendliest People - The **Best** Customer Service
PAYMENT PLAN with Credit Card -or- Layaway ONLY
COD's SINGLE PAYMENT ONLY

Email for Detailed Information
843-650-5700 For Questions-or- email: netcomd@aol.com
ORDERS ONLY 800-733-3733 **ORDERS ONLY** FAX 843 650 5777 10 - 8 EST Mon - Fri

Got a technical problem or question? Let our readers have a shot at solving it! E-Mail us at forum@nutsvolts.com.

Reader FeedBack

Dear Nuts & Volts:

Thanks for the complimentary Feb. 2000 issue. The first thing I read was the Tech Forum answers to #1007 on page 86.

Far be it from me to discourage anyone from learning DOS. DOS, UNIX, and LINIX are where it's at. Navigating the multi-layers of Windows for the Internet and such uses is one thing; working to understand computers is another.

Yes, Windows 95 has DOS 7 behind it as one can see by reading the COMMAND.COM file. About 1/3 of the way into that file, appears "MS-DOS Version 7." One who is proficient in DOS knows how to read that file.

The easiest way is to get Vernon Buerg's LIST utility. Write him at 139 White Oak Circle, Petaluma, CA 94952. (Tell him Homer Tilton and *Nuts & Volts* sent you!)

Another way is to use DEBUG with its (S)earch command. See the procedure on page 2.

Here's a little known but highly useful technique that works with MS-DOS versions 3.2 to 7.1, and maybe on future versions as well: You can use GWBASIC right at the DOS prompt just as if COMMAND.COM had a mathematical capability. If you have Microsoft GWBASIC.EXE archived from DOS 3.30 (not Tandy GWBASIC), dig it out and try this DOS command on a DOS or Windows 95 or 98 PC:

```
Echo ?2+2,3*3,4^4¦GWBASIC
```

(First, use the "Restart in MS-DOS" shutdown option.) That not only returns the answers to "What is 2 plus 2, 3 times 3, and 4 raised to the 4th power?" It also brings back the DOS prompt in preparation for your next DOS command. This kind of command can also be used in batch files. (If you use batch replaceable parameters %1, %2, etc., DOS will make the substitutions you give it as command parameters before it sends the instructions on to BASIC. Wow!)

No other flavor of BASIC is "smart" in that way. The method, accidentally discovered by Dave Bushong just before QBASIC was introduced, has become overlooked and lost. It seems Microsoft is totally unaware of it; indeed in *The MS-DOS Encyclopedia* – a Microsoft publication – they claim on page 759 that "the pipe symbol (¦) ... and any characters following it are ignored" in an Echo command!

The DOS "bible" is still Paul Somerson's 1988 1200-plus page tome, *DOS Power Tools* from Bantam Books, ISBN 0-553-34526-5.

Homer B. Tilton
Tucson, AZ

Dear Nuts & Volts:

Nuts & Volts readers seeing an item in the March Reader Feedback column, page 12, may be greatly misled by figures given there.

In the Reader Feedback column, Dave Bunting writes into Evert Fruitman about LEDs, claiming they're inefficient light sources.

Bunting states that LEDs are rated in microcandelas and using this assumption gives numbers showing LEDs are worse light sources than fluorescents or even tungsten lamps.

Unfortunately, in interpreting component ratings, Mr. Bunting or his quoted engineering brother may have made a very large error, confusing MICROcandelas with MILLIcandelas. This introduces a 1000x error, which is huge.

Many white light LEDs, such as HPs, are rated at 2000 mcd (millicandelas NOT microcandelas) or 2 candlepower, and this output is at 20 mA, or about 0.06 watt! It is thus quite possible to produce a lot of light with high energy efficiency: 33 candlepower per watt.

I suggest readers not be put off to LED usage because of this accidental misinterpretation. I've used these LEDs, and they are astoundingly bright, yet use very little power.

For sample information, see: http://www.semiconductor.agilent.com/news/pr/15mar99.html

Bert Koehler
via Internet

Dear Nuts & Volts:

Regarding Fred Blechman's March '00 "Build A Telephone-Busy Lite," to extend battery life, replace the LED with a flashing LED.

Look in All Electronics catalog, part #LED-60 works well.

Roger Flaten
via Internet

Dear Nuts & Volts:

The "Telephone-Busy Lite" project in your March issue is seriously flawed. It does not meet the FCC Type 68 telephone interface requirements, and the circuit design

Continued on page 72

Published Monthly By **T & L Publications, Inc.**
430 Princeland Court
Corona, CA 92879-1300
(909) 371-8497
FAX (909) 371-3052

E-Mail — editor@nutsvolts.com
URL — http://www.nutsvolts.com

Subscription Order ONLY Line
1-800-783-4624

PUBLISHER
Jack Lemieux *N6ZTD*

EDITOR
Larry Lemieux *KD6UWV*

MANAGING EDITOR
Robin Lemieux *KD6UWS*

ON-THE-ROAD EXHIBIT COORDINATOR
Audrey Lemieux *N6VXW*

SUBSCRIPTIONS
Abby Madain

CLASSIFIED ADS
Natalie Sigafus

DISPLAY ADS
Mary Gamar

by Allen Rushing, Ph. D.

Digital dB Using the BASIC Stamp II: A Lookup Table Approach

All Signals Great and Small

The problem with displaying wide-ranging signals is that the smallest values are hardly visible above zero, while the largest values may be saturated.

A solution adopted in some instruments to this dynamic range problem is to change the scale or range according to the instantaneous magnitude of the signal. But this can be inconvenient and, even if automatic (i.e., "autoranging"), may not be fast enough. And the action at the low end of any scale is much less visible than the action at the high end.

Another approach is to convert the signal to a decibel (dB) representation, where small and large magnitudes are equally visible on a single linear dB scale. The concept behind the dB representation is a logarithmic transformation. This stretches or amplifies the small values and compresses the large values. Logarithmic amplifiers perform this operation very fast in an analog fashion. After the transformation to dB, the smallest and largest signals are equally weighted on a percentage basis. For example, a 50% increase in a voltage signal magnitude, after conversion to dB, will be visible as a 3.5 dB change, whether the original signal is small or large.

Sound levels are conventionally expressed in terms of dB, because the dB scale is a better match to the human perception of sound intensity. Analog sound meters often display on multi-range non-linear dB scales. Audio "VU meter" (volume unit) scales are actually special dB scales. Radio-frequency signals are commonly converted to a dB scale. The logarithmic transformation can be usefully applied to DC values, as well as AC, even though the result may not usually be termed "dB."

Signals representing light intensity and exposure, optical transmittance, resistivity, concentration, and microbe count are routinely transformed logarithmically, or plotted on a logarithmic scale, to accommodate a wide dynamic range. The "f-stop" unit in photography, like dB, is an equal-percentage unit, and has a more linear relationship with the perceived effect on the photograph than would exposure time. One "f-stop" amounts to a 2x change in exposure or 6 dB (at 20 dB/decade). An example from chemistry is the "pH" unit; a one-unit change in pH amounts to a 10x change in ion concentration or 20 dB.

This project's objective is to logarithmically transform an input DC voltage signal, with an input range of a few millivolts to a few volts. The input may come from any source, and may represent a physical variable such as those mentioned above, or may simply be a circuit voltage with a wide dynamic range.

The BS2 Approach

The BASIC Stamp II (BS2) module, by Parallax, Inc., includes a microcontroller and EEPROM memory on a small circuit board. It is programmable (via the parallel port of a personal computer) in a high-level language — PBASIC — to control external hardware.

The circuit begins with a positive DC voltage input to be transformed to a dB scale. This input goes through an op-amp amplifier with real-time gain control to deliver a high-level positive voltage signal. In the amplifier stage, one of four feedback gains is selected by the BS2 such that the amplifier output is at a reasonably high level, without saturating.

The amplifier output is input to A/D converter ADC0804, whose eight output pins are connected to the BS2. Then the PBASIC program digitally transforms the A/D output to a logarithmic or scaled dB form.

At this point, we have a scaled dB result (0-255) in digital form. It can be monitored on the host computer screen using the "debug" feature of the BS2. To avoid tying up a computer, an LCD display could be interfaced to display the 0-255 result, or the rescaled 0-60 dB value. However, we have chosen to convert to analog form using the pulse-width modulation (PWM) instruction and just a single I/O pin, along with a low-pass filter. The one-byte dB result sets the duty-cycle of the PWM signal on the output pin. The RC filter smoothes the PWM signal, yielding the final scaled analog dB output voltage. The output of the RC filter can be connected to an ordinary scope or meter to monitor the scaled dB result. The program cycles endlessly to update the dB conversion.

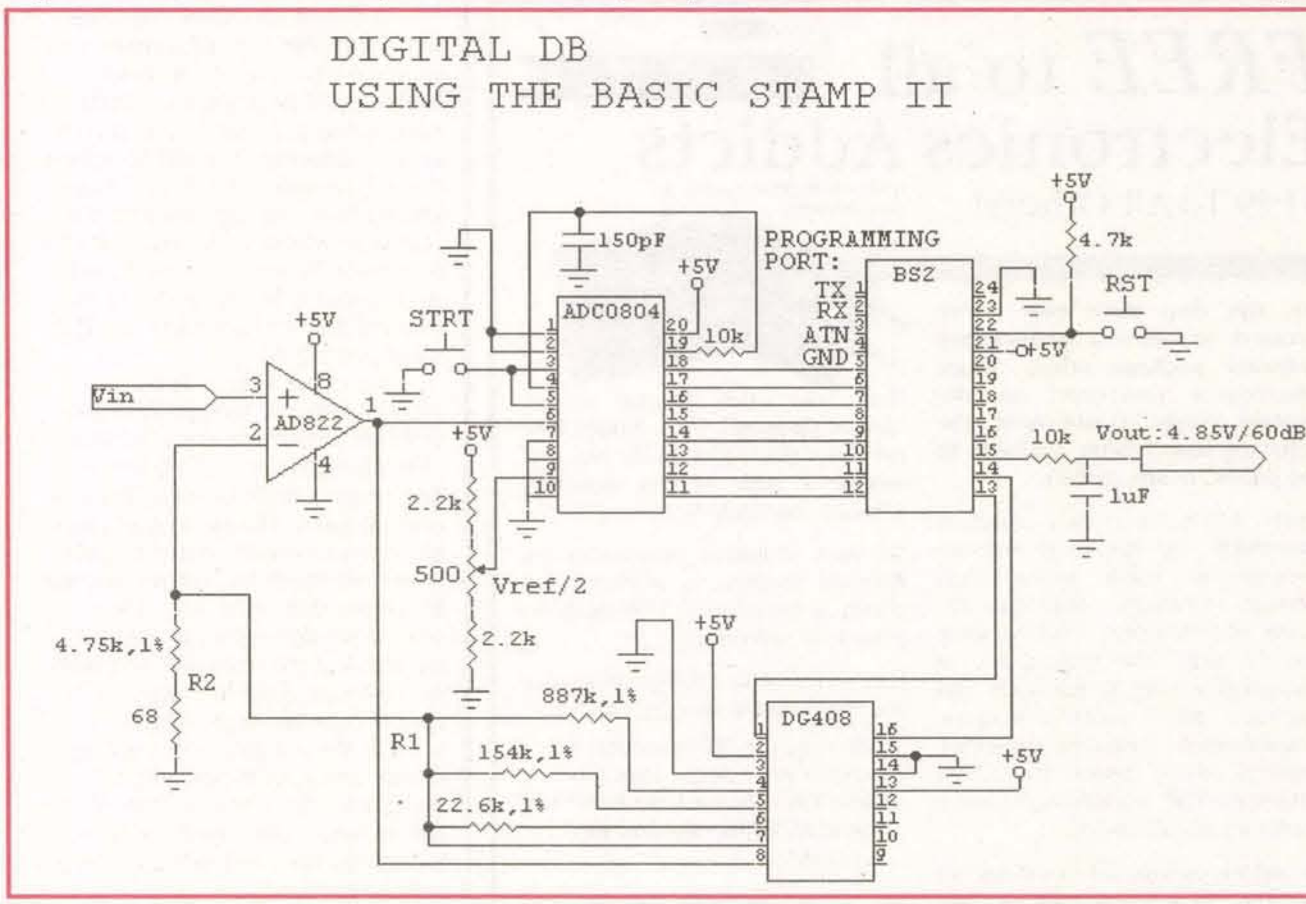
Scaled dB Equation

Mathematically, the logarithmic dB transformation accomplished by the BS2 circuit is given by

Vout = 20*log10(1000*Vin/Vmax)*(Vhi/60)

The factor (Vhi/60) scales the 60 dB range to the "high" level on the BS2 output pin (a few millivolts below Vdd). Otherwise, the equation above is the conventional way of transforming voltage levels to dB. The zero-dB reference point is Vmax/1000. Note the relationship of 20 dB per decade (factor of 10), which is conventional for voltage dB conversion. Conversion of power level to dB uses 10 dB per decade of power. There is no inconsistency since power goes as the square or voltage, i.e., a 10x change in voltage corresponds to a 100x change in power — 20 dB either way.

The maximum input, Vmax, is



```
' Title:  Digital dB Converter
' File Name:  db60.bs2
' Range:  60dB (3.0 decades)
' Resolution:  255 counts/60 dB = 4.25 counts/dB
' Hardware:  Basic Stamp II + op amp + A/D + analog mux
' Four selectable op amp gains in 5.623:1 ratio
' Author:  Allen Rushing, arushing@rochester.rr.com
'                 429 Tara Lane
'                 Webster, NY 14580
'                 Copyright(c) Allen Rushing (This work is unpublished.)
LUT00 data @0,0,0,1,2,3,3,4,5,6,6,7,8,8,9,10,10,11,11,12,13
LUT01 data @20,13,14,14,15,15,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23
LUT02 data @40,23,23,24,24,25,25,26,26,26,27,27,27,28,28,29,29,29,30,30,30
LUT03 data @60,31,31,32,32,32,33,33,33,34,34,34,34,35,35,35,36,36,36,37,37
LUT04 data @80,37,38,38,38,38,39,39,39,40,40,40,40,41,41,41,41,42,42,42,42
LUT05 data @100,43,43,43,43,44,44,44,44,45,45,45,45,46,46,46,46,47,47,47,47
LUT06 data @120,47,48,48,48,48,49,49,49,49,49,50,50,50,50,50,51,51,51,51,52
LUT07 data @140,52,52,52,52,53,53,53,53,53,53,54,54,54,54,54,55,55,55,55,55
LUT08 data @160,56,56,56,56,56,56,57,57,57,57,57,57,58,58,58,58,58,58,59,59
LUT09 data @180,59,59,59,59,60,60,60,60,60,60,61,61,61,61,61,61,61,62,62,62
LUT10 data @200,62,62,62,63,63,63,63,63,63,63,64
db      var     byte    '0-255 scaled decibel conversion of the input
delt    var     byte    'the db increment according to gain
k       var     word    'counter
ADC     var     inl     'A/D output byte, connected to BS2 P0(lsb) to P7(msb)
code    var     outh    'code (0-3) to select the op amp gain
dirl=%00000000  'low byte I/O pins (P0-7) receive A/D count as input
dirh=%00000111  'P8-9 for gain code output to DG408; P10 for PWM output
'code outputs gain code to switch: 0,1,2,3 for
'nominal gains of 178, 31.6, 5.62, 1.00, respectively.
'Initialize gain code; start with smallest gain (code=3)
 code=3
' k=0
again:                          'main loop
' pause 500                         'slow down to view debug; remove pause for
                                    'PWM
' if k=10000 then timeout
' k=k+1
 if ADC=255 then gmin_test          'A/D saturated?
 if ADC<45 then gmax_test           'A/D count too low?
'read scaled dB from the LUT; then add delt according to gain
 read ADC-45, db
 lookup code,[0,64,128,192],delt    'lookup the increment
 db=db+delt                         'db byte (0-255)
 pwm 10,db,5                  'DAC by pulse-width-modulated pin 10; 5 cycles
debug ? code, ? ADC, ? db, CR       'show the gain code & scaled db
                                    'enabling this debug slows down the update
                                    'rate
 goto again                                 'loop endlessly
gmin_test:                          'is the gain minimum?
 if code=3 then range_hi      'input is too big
 code=code+1                        'increment code to decrease gain
 goto again                                 'loop endlessly
gmax_test:                          'is the gain maximum?
 if code=0 then range_lo      'input is too small
 code=code-1                        'decrement code to increase gain
 goto again:                        'loop endlessly
range_hi:                           'error message:
 debug "input too big", CR    'input too big-saturated at min gain; db>255
 goto again                                 'loop endlessly
range_lo:                           'error message:
 debug "input too small", CR        'input too small for the LUT; db < 0
 goto again                                 'loop endlessly
timeout:
 debug ? k
 end
```

set by the minimum gain of the op-amp stage (1x in the circuit shown), times the span of the A/D converter (set to be Vhi by the Vref/2 adjustment). The Vmax input yields an output of 60 dB, which we scaled to Vout = 4.85V for a nominal five-volt BS2 supply voltage. For inputs equal to or less than Vin = Vmax /1000 (4.85 mV), the output Vout = 0.

The logarithmic slope is therefore ~81 mV/dB or 1.617 V/decade. Equal Vout increments correspond to equal dB and equal percentage changes of Vin. A 50% increase of a 10 mV input is just as visible as a 50% increase of a 1V input! Both are 3.5 dB increases, or 3.5*(4.85/60) = 283 mV increases in Vout for the circuit shown.

Circuit and Program Details

Since the BS2 has plenty of I/O pins, an eight-bit parallel output A/D is used. This permits a simpler PBASIC program and faster execution speed, compared to using a serial output A/D. The span adjustment — Vref/2 — is adjusted to be Vhi/2. This assures that the A/D output code = 255 when the A/D input = Vhi (~4.85 V) of the BS2.

In the circuit shown, Vref/2 is left alone after this adjustment. In a variation from the circuit shown, Vref/2 could be adjusted automatically by the BS2 and a D/A converter. This adjustment would effectively control the gain, and would be an alternative to the op-amp with the four gain resistors. But that is another project. In any case, the eight-bit A/D output is fed in parallel to INL (the pre-defined byte name for BS2 input pins P0-P7).

The circuit's range is 60 dB (1000:1 dynamic range). With the eight-bit output, we get 60/255 = .235 dB resolution (~2.7% of Vin). The range is determined by the four op-amp gains. The range could be extended to smaller inputs by using larger resistance for higher gain. But be careful that noise and offset error don't dominate the smallest inputs! And the resolution will worsen, since the eight-bit output is spread over the larger range.

For Vin > 4.85V, add a voltage divider ahead of the op-amp to avoid saturation. Bear in mind that this increases the zero-dB reference voltage by the same factor as the voltage division.

In selecting the op-amp gain values to cover the 3.0 decade (60 dB) range, considerations of resolution and resistor count must be balanced. We want a design that avoids skipping any of the 256 codes of the eight-bit output scaled dB. For any given gain, the log or dB output resolution worsens as Vin decreases. A single count at the low end of the A/D range represents a larger percentage (or dB) increment than a single count at the high end. To preserve resolution for a decreasing Vin, we must switch to the next-higher gain resistor before a dB output code value is skipped.

The next-higher gain resistor should be sized such that, at the switching point, the amplifier output is just below saturation. But don't switch too soon because that will require additional precision resistors to span the 3.0 decades. Four gain values in a 5.62:1 ratio, one-to-the-next, will do the job. In the non-inverting op-amp configuration shown, the gain is ideally related to the resistor values by

Gain = 1 + R1/R2

The DG408 analog switch selects R1 to be 0, 22.6k, 154k, or 887k. Resistance R2 is 4.75k in series with 68 ohms = 4.82k.

The op-amp is a precision single-power supply type (AD822) capable of driving the output close to the 0-5V power supply limits, i.e., "rail-to-rail." The resistors around the op-amp are standard 1% values.

The standard values shown are the ones that came closest — in testing one particular set of components — to giving the target 5.62:1 gain ratios, after accounting for Ron in the analog switch (~100 ohms). The result is eight-bit resolution over the 3.0 decades (60 dB) of Vin, with no skipped codes in the 0-255 scaled dB output.

Within the BS2, the A/D output byte forms the address for entering a table of scaled logarithms. The table is created and stored in EEPROM at compile-time by the DATA statements. The table values are derived assuming the nominal maximum gain is the actual maximum gain. This is the reason for the 1% tolerance on the input resistor and

the largest feedback resistor.

To form the scaled dB output byte (0 to 255), the log table output is augmented according to the op-amp gain (15 dB added for every step down in gain from the maximum gain, or 64 counts in the 0-255 scaled dB values). This operation assumes that all the actual gains equal the nominal gains, and is the reason for the 1% tolerance on the other feedback resistors.

When monitoring the dB analog output, use a high input-impedance (=>10 megohm) scope or meter to avoid loading the RC filter and introducing significant error. Or buffer the RC filter output with an op-amp follower.

Performance Limitations and Extensions

The input voltage should be DC or low-frequency AC, since the BS2 program loops and updates the output roughly every 10 mS. This update time is greatly increased if the digital dB is sent to the computer using "debug" or to an LCD. The PWM instruction, set for five cycles, accounts for about 5 mS of the update time. The update time defines the response speed of the digital dB conversion to a changing Vin. A further limitation on the analog output is the RC filter time constant of 10 mS. After a step change in the digital dB byte, several five-cycle PWM instructions are required to drive the RC filter to steady-state.

Where response speed is not an issue, analog output stability can be improved by increasing the capacitance in the RC filter. A longer RC time-constant essentially averages a larger number of digital updates. A bigger capacitor can also reduce the PWM charge-discharge amplitude if the load resistance is <10 megohm and there is a long update time during which the charge decays (e.g., because "debug" is in use).

The BS2 approach will be too slow for those applications requiring the speed of an analog logarithmic amplifier. But the BS2 circuit has reasonable accuracy as long as the input is not too small, and the flexibility for enhanced programmed features. For example, the program could be extended to compute the dB difference from a variable reference value, store a string of dB conversions for later output or review, check for alarm conditions, compute averages, max, min, etc. This flexibility opens the door to putting more "smarts" close to the signal source, rather than in the host instrument or computer.

Other possibilities involve multiplexed input channels handled by a single STAMP, with the STAMP computing channel differences, or other multivariable statistics.

BS1 Stampers who try adapting the digital dB application to the BS1 will face challenges: eight I/O pins rather than 16, and only 256 bytes of program memory rather than 2048. A serial A/D would reduce the I/O pins needed for the A/D. But the extra EEPROM needed to store the 211-byte LUT would require two or three more I/O pins. Performance compromises seem certain — in range, or resolution, or speed. But we are always surprised at what clever Stampers can do with limited resources!

Let us conclude with a more general point. The digital dB application demonstrates the use of a lookup table in a microcontroller, a technique adaptable for any arbitrary conversion of scale. The LUT approach is particularly appealing for nonlinear conversions, such as the logarithmic, or trigonometric, or non-linear sensor outputs, because the corresponding mathematical equation may be difficult to program, or may even be non-existent. **NV**

Available from **Digi-Key (1-800-344-4539, www.digikey.com)**:
BASIC Stamp II module
1% tol. resistors
(4.75K, 22.6K, 154K, 887 K) ¼-watt
5% tol. Resistor,
(68 ohm, 2.2K, 10K) ¼-watt
potentiometer, 500 ohm
1 uF capacitor
150 pF capacitor
push button

Available from **JDR Microdevices (1-800-538-5000, www.jdr.com)**:
Op-amp, type AD822
A/D converter, type ADC0804
Analog switch, type DG408DJ

WE BUY AND SELL

WESTERN TEST SYSTEMS

Inquiries **307-635-2269** • Fax **307-635-2291**

Orders **800-538-1493**

2701 Westland Court, Unit B, Cheyenne, Wyoming 82001

OSCILLOSCOPES & ACCESSORIES

OSCILLOSCOPES

- TEK 2445 150 MHz 4-channel Oscilloscope ... $950.00
- TEK 2465 300 MHz 4-channel Oscilloscope ... $1,500.00
- TEK 7104 1 GHz 2-Channel Oscilloscope, w/7A29,7A29-04,7B10,7B15 ... $2,000.00
- TEK 7844 400 MHz Dual Beam Oscilloscope with 7A24,7A26,7B80,7B85 ... $750.00
- TEK 7904 500 MHz Oscilloscope, with 7A24, 7A26, 7B80, 7B85 ... $750.00

PROBES

- HP 1122A Probe Power Supply ... $150.00
- TEK 1101 Accessory Power Supply, for FET probes ... $175.00
- TEK A6901 Ground Isolation Monitor ... $150.00
- TEK A6902B Voltage Isolator, DC-20 MHz, 20 mV-500 V/div. ... $500.00
- TEK P6046 100 MHz Differential Probe ... $400.00
- TEK P6101A pair 1X 34 MHz Probe pair, 10 Megohm/32pF, new in plastic ... $50.00
- TEK P6201 900 MHz 1X/10X/100X FET Probe ... $400.00
- TEK P6202A 500 MHz 10X FET Probe ... $200.00
- TEK P6205 750 MHz 10X FET Probe, for TDS series ... $325.00
- TEK P6701-opt.02 O/E Converter, 450-1050 nm/0-1 mW: DC-700 MHz, ST conn. ... $175.00

CALIBRATION

- TEK 067-0587-02 Signal Standardizer Calibration Fixture ... $750.00
- TEK SG503 Level Generator, 250 kHz-250 MHz, TM500 series ... $600.00

WAVEFORM GENERATORS

FUNCTION

- HP 3312A 13 MHz Function Generator ... $500.00
- HP 3314A-001 Function Generator, 0.001 Hz-19.99 MHz, 30 Vp-p, HPIB ... $1,200.00
- HP 3325A 21 MHz Synthesized Function Generator, HPIB ... $900.00
- HP 3325A-002 21 MHz Synthesized Function Generator, HV output option ... $1,200.00
- HP 8165A-002 Prog. Signal Source, 1 mHz-50 MHz, log sweep option ... $1,200.00
- TEK AWG5102 Arb.Waveform Gen., 20 MS/s,12 bits,50ppm synthesis <1MHz ... $650.00
- TEK AWG5105-opt.02 Arbitrary Waveform Generator, dual channel option ... $800.00
- TEK DD501 Digital Delay & Burst Gen., for function & pulse gen's ... $200.00
- TEK FG5010 Programmable 20 MHz Function Generator, TM5000 series ... $950.00
- TEK FG502 11 MHz Function Generator, TM500 series ... $275.00
- TEK FG503 3 MHz Function Generator, TM500 series ... $250.00
- TEK RG501 Ramp Generator, TM500 series ... $175.00
- WAVETEK 288 20 MHz Synthesized Function Generator, GPIB ... $650.00

PULSE

- BERKELEY NUCLEONICS 7085B Digital Delay Generator, 0-100 mS, 1 nS res.,5 Hz-5 MHz ... $550.00
- HP 8007B 100 MHz Pulse Generator ... $450.00
- HP 8012B 50 MHz Pulse Generator, variable transition time ... $500.00
- HP 8013B Dual Output 50 MHz Pulse Generator, 3.5 nS Tr ... $500.00
- HP 8080A/81A/83A/84A 300 MHz Word Generator ... $650.00
- HP 8080A/91A/92A/93A 1 GHz Single Channel Pulse Generator ... $800.00
- HP 8082A 250 MHz Pulse Generator ... $1,250.00
- HP 8111A 20 MHz Pulse/Function Generator ... $1,100.00
- TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series ... $600.00
- TEK PG508 50 MHz Pulse Generator, TM500 series ... $350.00
- WAVETEK 802 50 MHz Pulse Generator ... $250.00

VOLTAGE & CURRENT

VOLTMETERS

- FLUKE 845AR High Impedance Voltmeter / Null Detector ... $400.00
- HP 3456A 6-1/2 Digit Voltmeter, HPIB ... $450.00
- HP 3457A 7-1/2 digit Voltmeter, HPIB ... $1,000.00
- HP 3478A 5-1/2 digit Multimeter, HPIB ... $450.00
- KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB ... $800.00
- SOLARTRON 7081 8-1/2 digit Voltmeter ... $3,000.00
- TEK DM5010 4-1/2 digit Multimeter, TM5000 series plug-in ... $300.00
- TEK DM501A 4-1/2 digit Multimeter, TM500 series plug-in ... $225.00

CALIBRATION

- FLUKE 510A AC Reference Standard, 10 VRMS, 0-10 mA ... $450.00
- FLUKE 515A Portable Calibrator, DC/AC/Ohms, line & battery power ... $900.00
- FLUKE 5220A Transconductance Amplifier, DC-5 kHz, 0-20 A ... $2,500.00

VOLTAGE SOURCES

- HP 6115A Precision Dual Range Power Supply, 50V 0.8A / 100V 0.4A ... $750.00
- KEITHLEY 228 Programmable Voltage/Current Source ... $1,900.00
- TEK PS5004 Precision Programmable Power Supply, TM5000 series ... $1,000.00

CURRENT METERS & SOURCES

- HP 4140B Picoammeter / DC Voltage Source, without test fixture ... $1,500.00
- HP 6181C DC Current Source, to 100 V, 250 mA ... $500.00
- HP 6186C DC Current Source, to 300 V, 100 mA ... $750.00
- KEITHLEY 225 Current Source, 0.1 uA-100 mA, 10-100 V compliance ... $450.00
- KEITHLEY 227 Current Source, 1 uA-1 A, 0-50 V compliance ... $600.00
- TEK CT-5 High Current Transformer for P6021/A6302, to 1000A ... $375.00
- TEK P6022 AC Current Probe w/termination, 935 Hz-120 MHz, 6 A pk ... $275.00

IMPEDANCE & COMPONENT TEST

L.C.R.

- BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH ... $550.00
- BOONTON 72BD 1 MHz Capacitance Meter, 3-1/2 digit display ... $650.00
- BOONTON 72C 1 MHz Capacitance Meter, 1-3000 pF full scale ... $800.00
- GR 1658 RLC Digibridge, 120 Hz/ 1 kHz ... $1,000.00
- GR 1659 RLC Digibridge, 120 Hz/ 1 kHz/ 10 kHz ... $1,100.00
- HP 4192A LF Impedance Analyzer, 5 Hz-13 MHz ... $5,000.00
- HP 4262A-101 3-1/2 digit LCR Meter, 120 Hz/ 1 kHz/ 10 kHz test, HPIB ... $1,000.00
- HP 4342A Q-Meter, 22 kHz-70 MHz ... $950.00

STANDARDS

- E.S.I. SR-1 Standard Resistor, various values ... $125.00
- E.S.I. SR1010 Resistance Transfer Standards, 1 Ohm-100 K/step ... $550.00
- E.S.I. SR1050-1M Resistance Transfer Standard, 1 Megohm/step ... $2,000.00
- GR 1404-A 1000 pF Reference Standard Capacitor ... $700.00
- GR 1406 Standard Air Capacitors, GR900 connector, 0.1% acc. ... $275.00
- GR 1432-U 4-Decade Resistor, 0-111.10 Ohms, 0.01 Ohm resolution ... $100.00
- GR 1433-J 4-Decade Resistor, 0-11,110 Ohms, 1 Ohm resolution ... $150.00
- GR 1433-K 4-Decade Resistor, 0-1,110 Ohms, 0.1 Ohm resolution ... $150.00
- GR 1433-L 4-Decade Resistor, 0-111,100 Ohms, 10 Ohms resolution ... $150.00
- GR 1433-N 5-Decade Resistor, 0-11,111 Ohms, 0.1 Ohm resolution ... $200.00
- GR 1433-X 6-Decade Resistor, to 111,111.0 Ohms, 0.1 Ohm res. ... $250.00
- HP 4440B 4-Decade Capacitor, 40 pF-1.2 uF ... $750.00

T.D.R.

- TEK 1503B-03,04 T.D.R., 0-50,000 ft., chart recorder ... $3,000.00
- TEK 1503-opt.04 Time Domain 0-50,000 ft., chart recorder & battery power ... $1,400.00

POWER SUPPLIES

SINGLE OUTPUT

- HP 6110A 0-3000 V 0-6 mA CV/CL Power Supply ... $250.00
- HP 6200B Dual Range Supply, 0-20 V 0-1.5 A/ 0-40 V 0-750 mA CVCC ... $200.00
- HP 6207B 0-160 V 0-200 mA CV/CC Power Supply ... $200.00
- HP 6215A 0-25 V 0-400 mA CV/CL Power Supply ... $100.00
- HP 6256B 0-10 V 0-20 A CV/CC Power Supply ... $200.00
- HP 6263B 0-20 V 0-10 A CV/CC Power Supply ... $400.00
- HP 6266B 0-40 V 0-5 A CV/CC Power Supply ... $400.00
- HP 6267B 0-40 V 0-10 A CV/CC Power Supply ... $550.00
- HP 6271B 0-60 V 0-3 A CV/CC Power Supply ... $375.00
- HP 6274B 0-60 V 0-15 A CV/CC Power Supply ... $650.00
- HP 6282A 0-10 V 0-10 A CV/CC Power Supply ... $200.00
- HP 6289A 0-40 V 0-1.5 A CV/CC Power Supply ... $200.00
- HP 6299A 0-100 V 0-750 mA CV/CC Power Supply ... $200.00
- HP 6384A 4.0-5.5 V at 8 A CV/CL Power Supply ... $125.00
- HP 6443B 0-120 V 0-2.5 A CV/CC Power Supply ... $450.00
- HP 6632A System DC Power Supply, 0-20 V, 0-5 A, 100 Watts, HPIB ... $800.00
- HP 6652A 0-20 V 0-25 A 500 Watt Programmable Power Supply, HPIB ... $1,875.00
- KEPCO ATE 36-30M 0-36 V 0-30 A CV/CC Power Supply ... $900.00
- KEPCO ATE 36-8M 0-36 V 0-8 A CV/CC Power Supply ... $375.00
- LAMBDA LK-352-FM 0-60 V 0-15 A CV/CC Power Supply ... $600.00
- SORENSON DCR 150-3B 0-150 V 0-3 A CV/CC Power Supply ... $500.00
- SORENSON DCR 600-0.75B 0-600 V 0-750 mA CV/CC Power Supply ... $550.00
- SORENSON DCS 40-25 0-40 V 0-25 A CV/CC Power Supply ... $650.00
- SORENSON SRL 20-12 0-20 V 0-12 A CV/CC Power Supply ... $350.00
- SORENSON SRL 60-8 0-60 V 0-8 A CV/CC Power Supply ... $500.00
- TEK PS501-1 Power Supply, 0-20 V, 2 mV res., 400 mA, TM500 series ... $175.00

MULTIPLE OUTPUT

- HP 6205C Dual Power Supply, 0-40 V 300 mA & 0-20 V 600 mA, CV/CL ... $300.00
- HP 6228B Dual 0-50 V 0-1 A CV/CC Power Supply ... $375.00
- HP 6236B Triple Output Power Supply, +/- 0-20V 0.5A & 0-6V 2.5A ... $375.00
- HP 6253A Dual 0-20 V 0-3 A CV/CC Power Supply ... $375.00
- HP 6255A Dual 0-40 V 0-1.5 A CV/CC Power Supply ... $375.00
- KEPCO MPS-620M Triple Output Supply, dual 0-20V 1A tracking & 0-6V 5A ... $200.00
- LAMBDA LPT-7202-FM Triple Output Power Supply ... $450.00
- TEK PS5010 Programmable Triple Power Supply, TM5000 series ... $500.00
- TEK PS503A Dual Power Supply, TM500 series ... $200.00

MISCELLANEOUS

- ACME PS2L-500 Programmable Load, 0-75 V / 0-75 A / 500 Watts max. ... $350.00
- BEHLMAN 25-C-D/OSCD-1 AC Power Source, 250 VA, 0-130 VAC, 45-2000 Hz ... $850.00
- ELGAR 501C/400SD AC Power Source, 45 Hz-5 kHz, 500 VA, 0-135 VAC ... $1,150.00
- HP 59501B HPIB Isolated DAC/Power Supply Programmer ... $175.00
- HP 6060A 300 Watt Programmable Load, 0-60 A / 3-60 V, HPIB ... $950.00
- KEPCO BOP 20-20M Bipolar Op Amp/Power Supply, to 20 V 20 A ... $675.00
- KEPCO BOP 50-2M Bipolar Op Amp/Power Supply, to 50 V 2 A ... $400.00
- TRANSISTOR DEVICES DAL-50-15-100 Programmable Load, 0-50 V, 0-15 A, 100 Watts max. ... $200.00

TIME & FREQUENCY

UNIVERSAL COUNTERS

- HP 5314A-001 100 MHz/100 nS Universal Counter; TCXO reference option ... $250.00
- HP 5315A 100 MHz/100 nS Universal Counter ... $350.00
- HP 5315A-002,003 100 MHz/100 nS Univ. Counter; batt. power & 1 GHz C-ch. ... $550.00
- HP 5315A-003 100 MHz/100 nS Univ. Counter, 1 GHz C-channel option ... $450.00
- HP 5315B 100 MHz/ 100 nS Universal Counter ... $375.00
- HP 5316A 100 MHz/100 nS Universal Counter, HPIB ... $450.00
- HP 5316A-001,003 100 MHz/ 100 nS Univ. Counter, HPIB, TCXO, 1 GHz C-ch. ... $600.00
- HP 5316B 100 MHz/ 100 nS Universal Counter, HPIB ... $550.00
- HP 5335A-10,30,40 200 MHz/2 nS Universal Counter, OCXO ref., 1.3 GHz C-ch ... $950.00
- HP 5370A 100 MHz/ 20 pS 11 digit Universal Time Interval Counter ... $750.00
- HP 5370B 100 MHz/ 20 pS Universal Counter, 11 digits ... $1,200.00
- PHILIPS PM6672/411 120 MHz/100 nS Universal Counter, C-channel 70-1000 MHz ... $375.00
- TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, TM5000 series ... $200.00
- TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, TM5000 series ... $350.00
- TEK DC5010 350 MHz / 3.125 nS Universal Counter, TM5000 series ... $750.00
- TEK DC503A 125 MHz/100 nS Universal Counter, TM500 series ... $275.00
- TEK DC509 135 MHz/ 10 nS Universal Counter, TM500 series ... $275.00

FREQUENCY COUNTERS

- EIP 545A 18 GHz Frequency Counter ... $750.00
- FLUKE 7220A-010,131,351 1.3 GHz Counter; battery power, OCXO, and res. mult. ... $500.00
- HP 5340A-002 18 GHz Frequency Counter, rear panel input ... $450.00
- HP 5342A 18 GHz Frequency Counter ... $1,250.00
- HP 5343A-001 26.5 GHz Frequency Counter, OCXO reference ... $3,000.00
- HP 5343A-001,011 26.5 GHz Frequency Counter, OCXO reference, HPIB ... $3,500.00
- HP 5345A/5355A/5356B 26.5 GHz CW/Pulse Frequency Counter ... $3,500.00
- HP 5351B-001 26.5 GHz Frequency Counter, HPIB, OCXO reference ... $4,250.00
- HP 5364A Microwave Mixer / Detector, for modulation domain an. ... $2,000.00

STANDARDS

- HP 105B Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz, battery power ... $1,100.00
- HP 5087A-opt.032 Distribution Amplifier, 12 outputs at 5 MHz ... $1,750.00

AUDIO & BASEBAND

SPECTRUM ANALYSIS

- HP 3586C Selective Level Meter, 50 Hz-32.5 MHz, 50 & 75 ohms ... $1,200.00

DISTORTION ANALYZERS

- HP 334A Distortion Analyzer, 5 Hz-600 kHz, 0.06% THD ... $375.00
- HP 8903A Audio Analyzer, 20 Hz-100 kHz ... $1,200.00
- HP 8903B-001 Audio Analyzer, 20 Hz-100 kHz; rear input option ... $1,650.00

RMS VOLTMETERS

- FLUKE 8922A True RMS Voltmeter, 180 uV-700 V, 2 Hz-11 MHz ... $450.00

OSCILLATORS

- HP 3336C-004,005 21 MHz Synthesizer/ Level Gen., OCXO & hi accuracy att. ... $1,400.00
- TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten.,TM500 ... $200.00

MISCELLANEOUS

- HP 3575A-002 Phase-Gain Meter, 1 Hz-13 MHz, dual display ... $850.00
- HP 461A Amplifier, 20 dB or 40 dB gain, 1 kHz-150 MHz ... $125.00
- HP 467A Power Amplifier, X1/X2/X5/X10, DC-1 MHz, 10 W output ... $375.00
- KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave ... $350.00

Write In 73 on Reader Service Card.

90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION

TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS

KROHN-HITE 3200 High Pass / Low Pass Filter, 20 Hz-2 MHz, 24 dB/octave ... $275.00
KROHN-HITE 3202 Dual HP/LP/BP/BR Filter, 20 Hz-2 MHz, 24 dB/octave ... $450.00
KROHN-HITE 3342R Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave ... $900.00
ROCKLAND 852 Dual Highpass/ Lowpass Filter, 0.1 Hz-111 kHz ... $650.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series ... $475.00
WAVETEK 716 Brickwall Filter ... $1,500.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11517A/18A/19A/20A Mixer Set, 12.4-40.0 GHz, for HP 8555A/8569A ... $500.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz ... $1,100.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz ... $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz ... $1,400.00
HP 11971A WR28 Harmonic Mixer, for HP 8569B ... $800.00
HP 11971K WR42 Harmonic Mixer, for HP 8569B ... $800.00
HP 70620B Preamplifier, 1.0-26.5 GHz, for 70000 series ... $3,900.00
HP 8559A/853A-001 Spectrum An., 0.01-21 GHz, 1 kHz res.,w/rackmount frame ... $3,750.00
HP 85640A Tracking Generator, 300 kHz-2.9 GHz, for HP 8560 series ... $5,000.00
HP 8568B Spectrum Analyzer, 100 Hz-1.5 GHz, 10 Hz min. res. ... $8,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res.bw. ... $5,500.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz ... $1,500.00

NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit, APC7 ... $600.00
HP 11665B Modulator, 0.15-18 GHz, for HP 8755/6/7 ... $250.00
HP 35676A Reflection/Transmission Test Kit, 5 Hz-200 MHz ... $850.00
HP 85054A Type N Calibration Kit, for HP 8510 series ... $1,800.00
HP 8757A-001 Scalar Network Analyzer ... $3,750.00
HP 8757C-001 Scalar Network Analyzer; fourth detector input option ... $5,500.00
HP R85026A WR28 Detector, 26.5-40 GHz, for HP 8757 series ... $1,200.00

SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res., GPIB ... $1,900.00
FLUKE 6060A/AN Synthesized Signal Generator, 10 kHz-520 MHz, 10 Hz res ... $950.00
FLUKE 6060B/AK Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res. ... $1,900.00
GIGATRONICS 600/6-12 Synthesized Source, 6-12 GHz, 1 kHz res., GPIB ... $2,500.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm ... $2,500.00
GIGATRONICS 900/2-8 Synthesized Signal/Sweep Gen., 2-8 GHz, 1 MHz res.,GPIB ... $2,500.00
GIGATRONICS GT9000-opt.26A Synthesized Signal Gen., 0.01-20 GHz, 1 kHz res. ... $6,000.00
HP 11707A Test Plug-in for HP 8660 series ... $500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio ... $450.00
HP 3335A Synthesizer/ Level Gen., 200 Hz-81 MHz, -87 to +13 dBm ... $3,000.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm ... $3,750.00
HP 8640B Signal Generator, 0.5-512 MHz, AM, FM, pulse modulation ... $950.00
HP 8656A-001 Signal Generator, 0.1-990 MHz, 100 Hz res., HPIB, OCXO ... $1,600.00
HP 8657A-002 Signal Generator, 0.1-1040 MHz, 10 Hz res., HPIB ... $2,750.00
HP 8660C/86602A/86632B Synth. Sig. Gen., 1-1300 MHz, AM / FM ... $2,500.00
HP 8660C/86603A/86633B Synthesizer, 1-2600 MHz, 1 Hz res., AM / FM ... $3,250.00
HP 8672A Synthesized Signal Generator, 2-18 GHz, +3 dBm output ... $5,000.00
HP 8673G-004,008 Synth. CW Signal Generator, 2-26 GHz, >+8 dBm output ... $12,500.00
HP 8684B Signal Generator, 5.4-12.5 GHz, AM/ WBFM/ Pulse ... $3,000.00

SWEEP GENERATORS

HP 8340B Synthesized Sweep Generator, 10 MHz-26.5 GHz, AM, FM ... $20,000.00
HP 8350A/83540A-002,004 Sweep Oscillator, 2.0-8.4 GHz, 70 dB step attenuator ... $4,000.00
HP 8350A/83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step attenuator ... $4,000.00
HP 8350B/83522A Sweep Oscillator, 10-2400 MHz, +13 dBm levelled ... $4,000.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled ... $400.00
HP 8620C Sweep Oscillator Frame ... $550.00
HP 86222A RF Plug-in, 10-2400 MHz, +13 dBm levelled ... $1,200.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled ... $375.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled ... $300.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled ... $500.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled ... $500.00
HP 86290A-004 RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled, rear output ... $1,250.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld. ... $1,250.00
WILTRON 6647M Sweep Generator, 10 MHz-20 GHz, +10 dBm levelled ... $4,500.00

POWER METERS

ANRITSU MP-81B/ML-83A Power Meter, 75-110 GHz (WR10), -20 to +20 dBm ... $2,500.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor ... $450.00
HP 432A/478A Power Meter, -30 to +10 dBm, 10 MHz-10 GHz ... $300.00
HP 435B/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz ... $900.00
HP 435B/8482B Power Meter, 0 to +43 dBm, 100 kHz-4.2 GHz ... $1,500.00
HP 435B/8482H Power Meter, -10 to +34 dBm, 100 kHz-4.2 GHz ... $900.00
HP 436A-022/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz, HPIB ... $1,400.00
HP 436A-022/8484A Power Meter, -70 to -20 dBm, 10 MHz-18 GHz, HPIB ... $1,400.00
HP 8477A Power Meter Calibrator, for HP 432 series ... $500.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8 ... $1,500.00
HP R8486A WR28 Power Sensor, 26.5-40 GHz, for HP 435/6/7/8 ... $1,500.00
RACAL-DANA 9303 RF Millivoltmeter, 10 kHz-2 GHz, -70 to +20 dBm ... $750.00

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 4W1000 Amplifier, 40 dB gain, 4 Watts, 1-1000 MHz ... $950.00
HP 11729B-003 Carrier Noise Test Set, 5 MHz-3.2 GHz ... $2,250.00
HP 415E SWR Meter ... $200.00
HP 8406A Comb Generator, 1/ 10/ 100 MHz increments, to 5 GHz ... $500.00
HP 8447A Amplifier, 20 dB, 0.1-400 MHz, 5 dB NF, +6 dBm output ... $375.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output ... $750.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz ... $1,750.00
HP 8901B-1,2,3 Modulation An., 0.15-1300 MHz, rear input, OCXO, ext.LO ... $2,250.00
HP 8970A Noise Figure Meter ... $4,000.00
HUGHES 1177H10F000 TWT Amplifier, >30 dB gain, 1.4-2.4 GHz, 20 Watts ... $2,500.00
HUGHES 8010H13F000 TWT Amplifier, >30 dB gain, 3-8 GHz, 10 Watts ... $2,500.00
HUGHES 8020H01F000 TWT Amplifier, >30 dB gain, 2-4 GHz, 20 Watts ... $4,250.00
RF POWER LABS ML50 Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28V ... $350.00
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz ... $3,750.00

COAXIAL & WAVEGUIDE

AEROWAVE 28-3000/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz ... $300.00
AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW* ... $95.00
AVANTEK AMT-400X2 WR28 Active Doubler, +10 dBm in/ +10 dBm out 26-40 GHz ... $450.00
BIRD 6735-300 1 kW Load, 25-1000 MHz, LC(f), with wattmeter ... $650.00
BIRD 8201 500 Watt Oil Dielectric Load, DC-2.5 GHz, N(f) ... $350.00
BIRD 8251 1 kW Oil Dielectric Load, DC-2.4 GHz, N(f) ... $500.00
BIRD 8325-30 30 dB Attenuator, 500 Watts, DC-500 MHz ... $400.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f) ... $125.00
FXR/MICROLAB SL-03N Stub Stretcher, 0.3-6.0 GHz, 100 Watts max., N(m/f) ... $75.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz ... $400.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ... $450.00
HP 11636A 2-Way Power Divider, DC-18 GHz, N(m/f/f) ... $300.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz ... $800.00
HP 33321K Programmable Step Atten., 0-70 dB, DC-26.5 GHz, 3.5mm ... $475.00
HP 33327L-006 Programmable Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm ... $1,000.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz ... $275.00
HP 776D Dual Directional Coupler, 20 dB, 940-1900 MHz ... $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz ... $275.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC7 test port ... $450.00
HP 83017A Amplifier, 25 dB gain, 0.5-26.5 GHz, >+15 dBm ... $3,250.00
HP 8431A 2-4 GHz Band Pass Filter, N(m/f) ... $150.00
HP 8472B Crystal Detector, 10 MHz-18 GHz, negative polarity, SMA ... $225.00
HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA ... $350.00
HP 8495H-001 Programmable Step Attenuator, 0-70 dB, DC-18 GHz, N ... $400.00
HP 8496A-002 Step Attenuator, 0-110 dB, DC-4 GHz, SMA ... $375.00
HP 8497K-004 Programmable Step Attenuator, 0-90 dB, DC-26.5 GHz ... $750.00
HP K382A WR42 Direct Reading Attenuator, 0-50 dB, 18.0-26.5 GHz ... $2,750.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz ... $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz ... $450.00
HP K752C WR42 Directional Coupler, 10 dB, 18.0-26.5 GHz ... $450.00
HP K752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz ... $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz ... $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz ... $300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz ... $650.00
HP R382A WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz ... $2,250.00
HP R422A WR28 Crystal Detector, 26.5-40 GHz ... $400.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz ... $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz ... $250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz ... $750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz ... $650.00
HP X870A WR90 Slide Screw Tuner ... $150.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz ... $900.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz ... $900.00
HUGHES 45716H-1000 WR10 Frequency Meter, 75-110 GHz ... $900.00
HUGHES 45721H-2000 WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz ... $1,000.00
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz ... $1,000.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz ... $250.00
HUGHES 45772H-1100 WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz ... $400.00
HUGHES 45773H-1100 WR19 Thermistor Mount, -20 to +10 dBm, 40-60 GHz ... $650.00
HUGHES 45774H-1100 WR15 Thermistor Mount, -20 to +10 dBm, 50-75 GHz ... $750.00
HUGHES 45775H-1100 WR12 Thermistor Mount, -20 to +10 dBm, 60-90 GHz ... $800.00
HUGHES 45776H-1100 WR10 Thermistor Mount, -20 to +10 dBm, 89-99 GHz ... $700.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity ... $600.00
HUGHES 47741H-2310 WR28 Phase Locked Gunn Osc., 32.000 GHz, +18 dBm ... $2,000.00
HUGHES 47742H-1210 WR22 Phase Locked Gunn Osc., 42.000 GHz, +18 dBm ... $2,750.00
HUGHES 47974H-1000 WR15 SPST PIN Switch, 250 MHz speed, 60-62 GHz response ... $375.00
KRYTAR 201020010 Directional Detector, 1-20 GHz, SMA(f/f)/SMC ... $200.00
KRYTAR 2616S Directional Detector, 1.7-26.5 GHz, K(f/m)/SMC ... $200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz ... $450.00
MICA C-121S06 Circulator, 17.5-24.5 GHz, SMA(f/m/m) ... $75.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f) ... $25.00
NARDA 3000-SERIES Directional Couplers ... $150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz ... $375.00
NARDA 3090-SERIES Precision High Directivity Couplers ... $225.00
NARDA 368BNM Coaxial High Power Load, 500 Watts, 2.0-18 GHz, N(m) ... $500.00
NARDA 3752 Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz ... $1,000.00
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz ... $1,000.00
NARDA 4000-SERIES SMA Miniature Directional Couplers ... $75.00
NARDA 4226-10 Directional Coupler, 10 dB, 0.5-18.0 GHz, SMA(f) ... $275.00
NARDA 4227-16 Directional Coupler, 16 dB, 1.7-26.5 GHz, 3.5mm(f) ... $325.00
NARDA 4242-20 Directional Coupler, 20 dB, 0.5-2.0 GHz, SMA(f) ... $100.00
NARDA 4247-20 Directional Coupler, 20 dB, 6.0-26.5 GHz, 3.5mm(f) ... $200.00
NARDA 4247B-10 Directional Coupler, 10 dB, 6.0-26.5 GHz, 3.5mm(f) ... $200.00
NARDA 5070-SERIES Precision Reflectometer Couplers ... $300.00
NARDA 562 DC Block, 10 MHz-12.4 GHz, 100 V max., N(m/f) ... $65.00
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) ... $165.00
NARDA 791FM Variable Attenuator, 0-37 dB, 2.0-12.4 GHz ... $600.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz ... $375.00
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB, 4-8 GHz ... $375.00
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f) ... $50.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz ... $250.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz ... $75.00
TEKTRONIX 2701 Step Attenuator, 0-79 dB, DC-1 GHz, AC or DC coupled ... $175.00
TRG B510 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz ... $1,000.00
TRG V551 WR15 Frequency Meter, 50-75 GHz ... $600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz ... $750.00
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB ... $200.00
WEINSCHEL 150-110 Programmable Step Attenuator, 0-110 dB, DC-18 GHz, SMA ... $450.00
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f) ... $150.00
WEINSCHEL DS109LL Double Stub Tuner, 0.2-2.0 GHz, N(m/f) ... $150.00

COMMUNICATIONS

HP 3780A-001 Pattern Generator / Error Detector, 1 kb/s - 50 Mb/s ... $1,000.00
HP 4934A Transmission Impairment Measuring Set ... $1,500.00
HP 4935A Transmission Impairment Measuring Set ... $600.00
HP 59401A HPIB Bus Analyzer ... $375.00
MICRODYNE 1200MR 215-320 MHz Telemetry Receiver, PSK demodulation ... $600.00
TEK 1410R NTSC Gen., w/SPG2 sync. generator, TSG7 color bars ... $800.00
TEK 1411R PAL Gen.,w/SPG12 sync;TSG11 color bars;TSG13 linearity ... $750.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11,TSG13,TSG15,TSG16 ... $1,000.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11,TSG12,TSG13,TSG15,TSG16 ... $1,100.00
TEK 1411R-opt.04 PAL Test Gen.,w/ SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 ... $1,400.00
TEK 147A NTSC Test Signal Generator, with noise test signal ... $800.00
TEK 148 PAL Insertion Test Signal Generator ... $700.00
TEK 520A NTSC Vectorscope ... $750.00
TEK 521A PAL Vectorscope ... $750.00

MISCELLANEOUS

FLUKE 2180A RTD Digital Thermometer ... $500.00
HP 7090A Measurement Plotting System ... $1,200.00
P.A.R. 124/116 Lock-In Amplifier ... $1,500.00
P.A.R. 5206-95,98 Two-Phase Lock-in Amp., 2 Hz-100 kHz, GPIB ... $1,500.00
TEK TM5003 5000-series 3-slot Programmable Power Module ... $450.00
TEK TM5006 5000-series 6-slot Programmable Power Module ... $500.00
TEK TM504 500-series 4-slot Power Module ... $175.00
TEK TM506 500-series 6-slot Power Module ... $250.00
TEK TM515 500-series 5-slot Traveller Power Module ... $250.00

Write in 73 on Reader Service Card.

Newsbytes

SURF THE WEB IN PRIVACY WITH SURFSECRET™

Advercast LLC has released version 2.9R of its popular privacy utility. Several new features have been added, as well as support for the Windows 2000 operating system.

SurfSecret is a complete privacy tool. Surf anywhere you want — and SurfSecret will clear your tracks so that nobody will know where you've browsed. As you surf the web, pictures and text get stored on your hard disk, creating a mirror image of your surfing experience. Browsers create cache files and store information on your hard disk, creating a trail that can be easily read. SurfSecret is designed to periodically destroy this trail.

Designed to work on Windows 95/98/NT/2000, SurfSecret integrates with popular browsers such as Netscape, MS Internet Explorer, and AOL. SurfSecret also cleans tracks in important windows locations such as the document menu, run menu, find menu, and Recycle Bin. It runs quietly from the system tray, eliminating telltale files at a regular interval of your choosing. Other features include Stealth Mode and Password Protection — to keep its operation secret.

Version 2.9R adds two new features to the SurfSecret arsenal of privacy tools. "Keystroke Wakeup" allows the user to remove all visual instances of SurfSecret from the desktop. SurfSecret then hides in memory running silently until a certain keystroke combination is typed. "Cookie Saver" allows the user to instruct SurfSecret to save certain cookies from trusted sites.

SurfSecret 2.9R for Windows costs $29.95 for a single-user license. SurfSecret LITE for AOL, SurfSecret LITE for IE, and SurfSecret LITE for Netscape all cost $19.95 for a single-user license. Site licenses are available for all products. For more information and to download the evaluation copy, visit the SurfSecret Web site at http://www.surfsecret.com.

SUPERBOT DOWNLOADS ENTIRE WEBSITES WITH A SINGLE CLICK

EliteSys announces the release of SuperBot 2.1 — an automated download utility for Windows 95/98/NT4 that copies entire Internet sites with as little as one click. Thanks to SuperBot's HTML rewriting technology, copied sites look and act just like their online counterparts.

Once SuperBot has downloaded a website, it can be viewed in any web browser, at high speed and without a Internet connection. Modem users are therefore able to surf the Net without missing calls. A copied site can be transferred directly to floppy disk or CD (or any other storage medium) for archival or distribution purposes.

SuperBot's intuitive interface is perfect for both new and experienced users. Although the default settings make perfect copies of most websites, SuperBot can be configured to filter downloads by location, date, file type, link type, depth, and file count. Once a copy operation has begun, it can be paused, stopped, and restarted easily. SuperBot utilizes HTTP/1.1 "Smart Restart" technology to resume any partially completed file transfers.

SuperBot coordinates seamlessly with your computer's web browser. With the "Monitor clipboard" feature, you can download a website by merely copying its address and pressing Enter. SuperBot can automatically launch a copied site in your browser, as well as recording its location in a log file. Because SuperBot preserves the downloaded files' format and directory structure, they can also be viewed or manipulated with Windows Explorer.

SuperBot costs $24.95. An evaluation copy may be downloaded from the EliteSys website at http://web.idirect.com/~elitesys/superbot. Internet Explorer 4.0 or above is required.

Open Channel

by Joseph J. Carr

Dummy Loads and the USB Port

This month, let's take a look at dummy loads and the USB port (Jan Axelson has a new book on the port). The topic of dummy loads has fascinated me for a long time. A "dummy load" is a load for a transmitter that does not radiate.

When I was a kid, we used a light bulb on 60 to 90 watt transmitters for dummy loads. That is, until I worked a guy across town with an S-9 receiver S-meter reading, while "transmitting" into that dummy load! Ooops!

One reason to use a dummy load is to adjust the transmitter off-the-air while transmitting. Another is to measure the RF power level produced by the transmitter.

Measuring RF Power Output

The RF power can be measured with the set-up shown in Figure 1. In this instance, an RF wattmeter is connected to a dummy load. When the transmitter is keyed, the RF power is indicated on the wattmeter. Unless the wattmeter is designed for modulated signals, the unmodulated RF output power is used.

RF power can also be measured by measuring the RF voltage across the load ($P = E^2/R$) or the current flowing in the load ($P = I^2R$).

Dummy Loads

So, what exactly is a dummy load? A dummy load is a non-radiating substitute for an antenna. That is, perhaps, why the British have traditionally called these devices "artificial aerials."

So, why use a dummy load instead of radiating directly from the antenna? Several reasons. First, it is illegal in most countries to radiate a signal when testing transmitters if it interferes with other users on the channel. One is allowed to radiate only RF energy needed for communications. Another reason is that it is just plain rude to cause interference on a radio channel just because you want to test your transmitter. Rather than pressing the push-to-talk and interfering with other stations, we can silently key the power into a dummy load.

And finally, there is a very good technical reason for using a dummy load to test a transmitter: Antennas cannot be relied upon to provide the constant and consistent test load that is necessary to make sense out of transmitter tests and adjustments. The measurements that you make may not match the specifications given in the transmitter's manual, even though there is nothing wrong.

Figure 2 shows the standard circuit for the dummy load. It consists of a non-inductive resistor mounted inside of a shielded enclosure, with either a coaxial connector or other transmission line connector to the outside world.

The resistor has to be non-inductive so that the impedance it represented is similar to what would be seen on a resonant antenna. For most applications, an impedance of 50 ohms is used as the system impedance, although examples of 75-ohm, 300-ohm, 450-ohm, and 600-ohm systems are also occasionally seen. Most modern transmitters are designed to work into a 50-ohm resistive load.

Resistive Loads?

The impedance of any load can be described by:

$$Z_L = \sqrt{R^2 + (X_L - X_C)^2}$$

where:

R is the resistive component
XL is the inductive reactance component
XC is the capacitive reactance component

If an antenna is resonant, then XC = XL, so the reactances cancel out leaving only the resistive component. But not all antennas work directly on resonance, especially if they are required to work over a band of frequencies. When the transmitter frequency is lower than the resonant frequency, the antenna appears too short and exhibits some capacitive reactance (XC).

The usual solution is to add some inductive reactance (XL) to cancel it out. Similarly, when the exciting frequency is above the resonant frequency, the antenna appears too long and exhibits inductive reactance. In both cases, the impedance will not be resistive, but rather complex.

The assumption that we will see only resistive loads is reasonable for some transmitters, but for others it is a fallacy. Whether or not it is true depends on the nature of the antenna system connected to the transmitter, and whether or not the transmitter stays on one frequency. For now, however, we will make the resistive assumption.

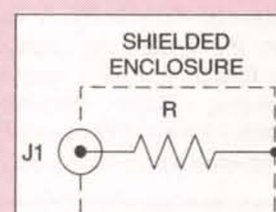


Figure 2 - Dummy load schematic symbol.

Simple Dummy Loads

There are

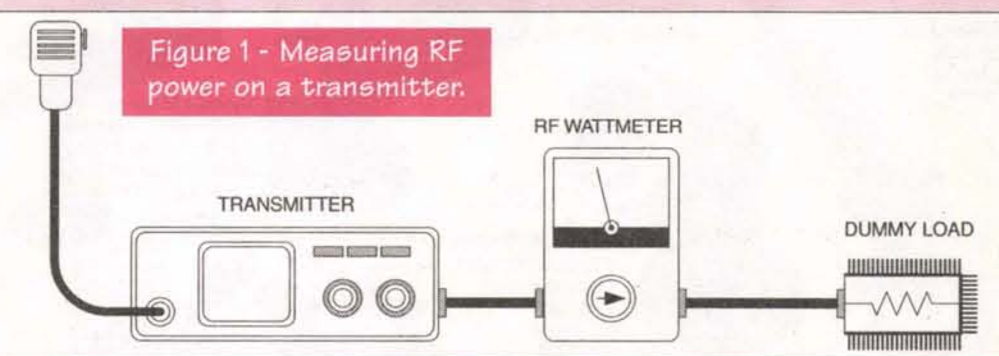


Figure 1 - Measuring RF power on a transmitter.

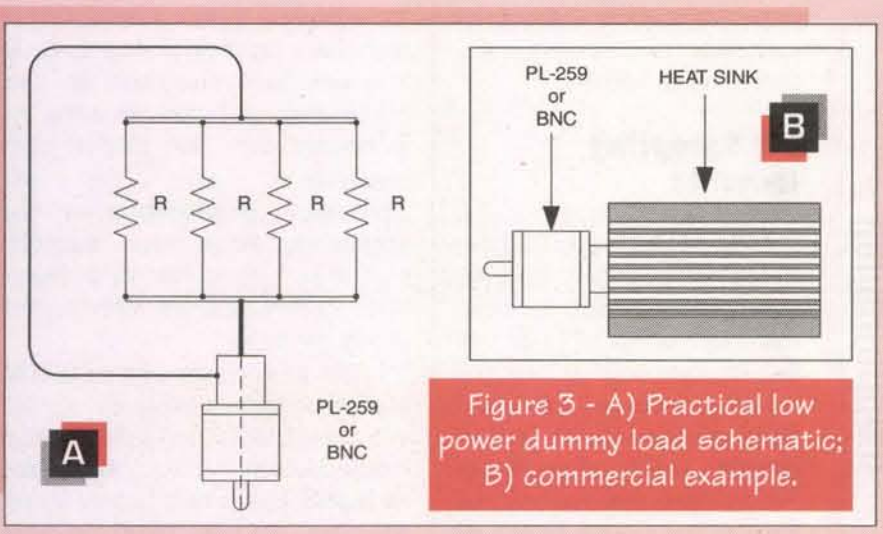


Figure 3 - A) Practical low power dummy load schematic; B) commercial example.

a number of dummy loads that you can buy from commercial sources, but for now let's take a look at some basic forms. Figure 3A shows a simple low-power dummy load that can be used on HF QRP rigs, or many VHF transmitters up to the VHF bands. It consists of two or more parallel resistors (R) connected across either a male BNC connector or a PL-259 "UHF" coaxial connector, depending on the particular transmitter it is used to test.

The values of the resistors depend on the power level and the particular impedance being created. Let's assume 50 ohms for the overall impedance. If you place four 200-ohm resistors in parallel, then you will have a 50-ohm impedance. The power rating will be the total power rating of the resistors. For example, if you use one-watt resistors, then it will be a four-watt dummy load. Similarly, if the dummy load is made from two-watt resistors, an eight-watt load is created. The resistors should be either carbon composition or metallic film. In no case should they be wire-wound resistors.

Higher power levels can be accommodated by using a larger number of resistors, with correspondingly higher value resistances in Figure 3A. Twenty 1,000-ohm, two-watt resistors can be used to make a 40-watt load. However, keep in mind that the higher the number of resistors, the greater the distributed capacitances, which essentially limits the frequency response of the load.

Small dummy loads are built in this manner. Figure 3B shows a representation of a common 20- to 50-watt dummy load used in both commercial and amateur communications testing.

Oil-Filled Paint Can Dummy Antenna

A popular approach to making high power ham radio (or impromptu commercial) dummy loads is the paint can dummy antenna. These loads were popularized by the old Heathkit Cantenna. It consists of a standard one-gallon paint can. A non-inductive 50-ohm power resistor is placed inside the can, and the can is then filled with either motor oil or mineral oil (at least one commercial variant used a silicone oil, I am told).

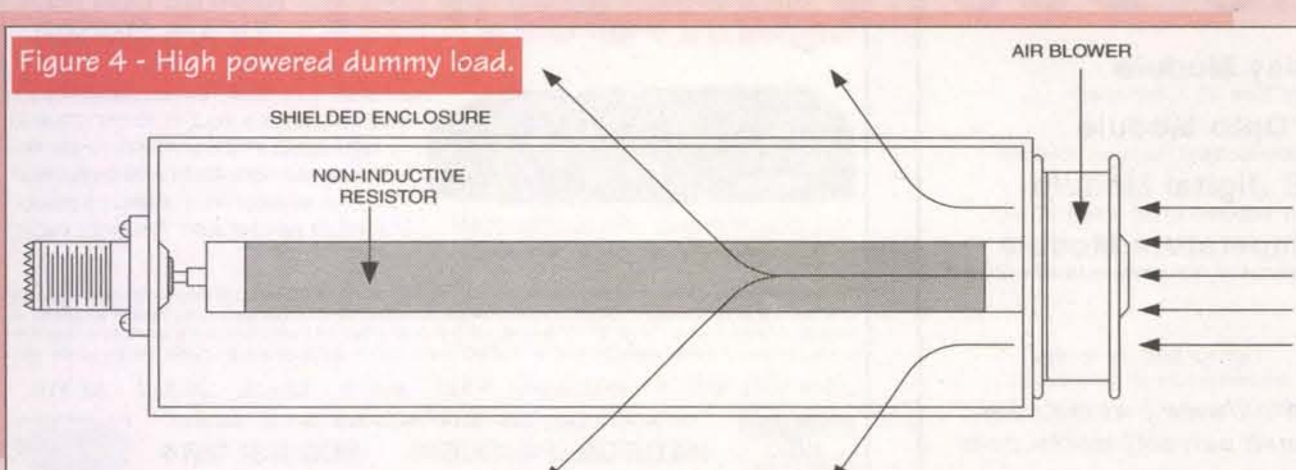
When searching for resistors, you must find a non-inductive resistor. Nearly all of the power resistors that you will find are wire wound, and not usable as a dummy load. You can recognize the non-inductive resistor because it will be a ceramic cylinder with a coating of carbon-like material on the outer surface. In some cases, there will not be any connectors. The electrical connection is provided by hose clamps connected to the ends.

Air-Cooled Dummy Loads

The air-cooled dummy load is probably a lot more practical than oil-filled loads. The down side is that the power rating of the resistor element must be higher. Oil-filled loads can be operated at higher than rated powers because the oil couples heat to the surface of the can where it can be radiated to the air around it. Commercial dummy loads at high powers (up to 50 kW are easily obtained) use either internal oil or an external water jacket to carry heat away from the resistor element.

Figure 4 shows a basic air-cooled dummy load. This figure represents a large number of 250-watt to 2,500-watt dummy loads. Most are built without the fan, although I've seen many commercially-available models that have the blower fan cut-outs on one end of the perforated aluminum cabinet. If you want to increase the power rating of the dummy load, then add the fan and get rid of the heat.

Another approach is shown in Figure 5. This type of dummy load uses a finned heatsink to radiate away the heat dissipated by the dummy load resistor. The internal cavity of the dummy load might be filled with either oil or a silicone gel material that matches the thermal impedance of the resistor to that of

Figure 4 - High powered dummy load.


Dummy Loads and the USB

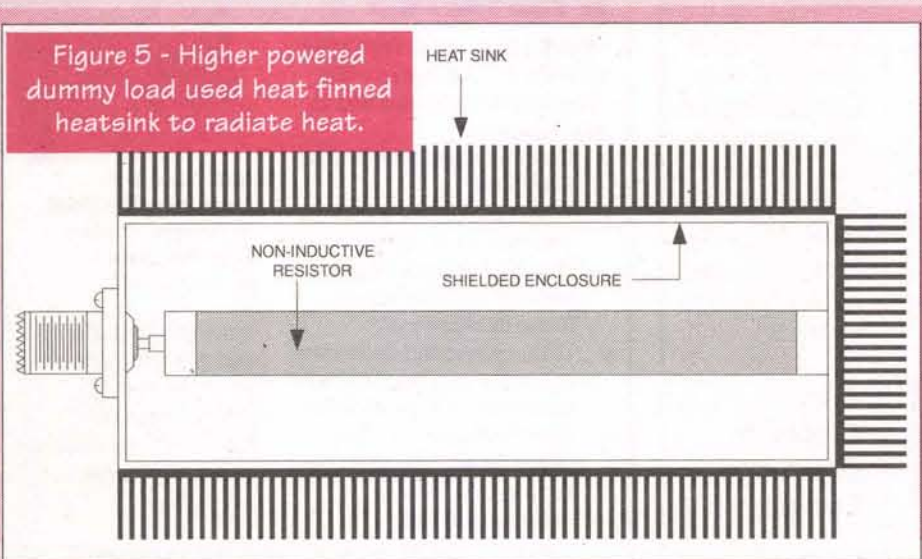


Figure 5 - Higher powered dummy load used heat finned heatsink to radiate heat.

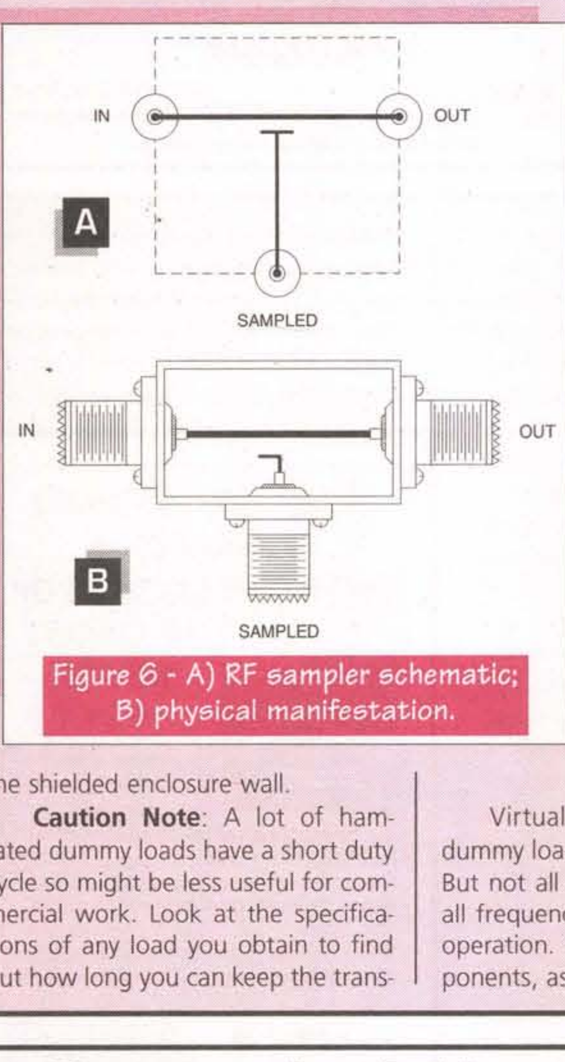


Figure 6 - A) RF sampler schematic; B) physical manifestation.

the shielded enclosure wall.

Caution Note: A lot of ham-rated dummy loads have a short duty cycle so might be less useful for commercial work. Look at the specifications of any load you obtain to find out how long you can keep the transmitter keyed without damaging the resistor. Some of them have remarkably short duty cycles. One model I saw said "60-seconds off for 10-seconds on." That means a one-minute cooling off period is needed every time you key the transmitter for 10 seconds. If a particular model looks a bit too small for the wattage rating printed in big letters, then look at the fine print to see the duty cycle rating.

Complex Impedance Dummy Loads?

Virtually every commercial dummy load is a resistive impedance. But not all antennas are resonant at all frequencies within their bands of operation. Some have reactive components, as well as resistive. In those instances, suitable amounts of capacitive or inductive reactance will be needed.

RF Sampling Devices

Some dummy loads have RF sampling circuits built in, while in other cases, an external device needs to be provided. Devices such as isolated hybrid combiners and directional couplers can be used to provide a sample of the RF signal. Another approach is the coupled tee connector shown in Figure 6. The IN/OUT path is a straight transmission line, in which the SAMPLED port is connected to a wire or small single-turn loop in close proximity to the transmission line. It picks off a small sample of the signal and feeds it to other instruments used in the measurement process.

The RF sample can be used to view the modulation waveform on a Y-time oscilloscope, or display it on a spectrum analyzer. It can also be used to drive an RF power meter if the attenuation factor is known.

New Book

Nuts & Volts writer Jan Axelson has done it again. She's added the book *USB Complete* (ISBN 0-9650819-3-1) to her line up of "...Complete" books (*Parallel Port Complete* and *Serial Port Complete*). The sub-title of this book is "Everything You Need to Develop Custom USB Peripherals," and the book lives up to its billing. If you want to add the Universal Serial Bus (USB) port to your repertoire, then this is the book for you.

For developers who are deciding whether the USB is the right choice for a project, there's a discussion of the USB's abilities and limitations. You will find information on controller chips and how to write the embedded code that permits communications with the PC. Applications programmers will find step-by-step Visual Basic examples that show how to identify a device, open communications with it, and exchange data.

This book comes with a CD-ROM containing various programs for use with the USB. It is available from **Amazon.com** or **Lakeview Research** [2209 Winnebago Street, Madison, WI 53704; **(608) 241-5824** (voice), **(608) 241-5848** (FAX), E-Mail: info@lvr.com, website http://www.lvr.com]. More information is available on the USB at the USB Implementers Forums web site (http://www.usb.org).

The USB interface is a joint effort of Compaq, Intel, Microsoft, NEC, and other manufacturers involved with PC hardware. Advantages to USB include hot pluggability, automatic detection of devices by the operating system, no user configuration required (!), built-in power conservation features, and the ability of many peripherals to use bus power (so they don't need "wall bug" transformers to power them). The bus transfers data at 12 megabits per second, and supports error correction and guaranteed delivery rates. Inexpensive ports allow users to expand the number of ports beyond the usual two provided on most PCs. **NV**

Connections ...
I can be reached by snail mail at P.O. Box 1099, Falls Church, VA 22041, or via E-Mail at CARRJJ@AOL.COM.

VERY UNUSUAL, PITTMAN MOTOR with OPTICAL ENCODER and Flex Coupled, VACUUM SEALING, Output Shaft.

Pittman P/N: 14204C223. All metal construction with replaceable brushes. Approximately 4087RPM no load speed. Shaft is 0.37" diam. X 1.75" Long. Overall size: 2.8" max. O.D. x 9"L not including shafts. Ball bearing outputs. Torque 14 OZ. in continuous, Peak torque, 107 OZ-in, Nominal operating voltage: 30.3 VDC, No load current 190mA, Stall Current: 19.9A, Encoder is BEI, MX-21 series. P/N:MX-213-25-100048. Quadrature with index. 1000ppr, 4000ppr quadrature. 5VDC @ 80mA powered. Square wave output TTL compatible. **Pittman Precision, Special..........$59ea.**

NEW! COLEMAN DC MOTOR, for general purpose applications.

Size: 1"diam.x2.5"long. Small 5/16"diam belt drive pully attached. 12VDC power, 200mA, No Load 6000 RPM Rugged construction. Tach output too!

APRIL DEAL, COLEMAN....10 for $20

SONY, ROBOTIC, COLOR CONFERENCE CAM. Over 450Lines, 8X zoom, PAL & Y/C OUT, WINDOWS 95/98 Control Software Too!

NOTE: This is the PAL (European version) Serial Control of Pan, Tilt, Zoom, Auto Iris and Auto Focus too! Like having your own R2D2. Intended for use in fortune 500 board rooms. The video performance is stunning. Superior to almost anything we have seen. Camera and lens is an integral assembly. Excellent Condition. I/O is on 8 pin mini-DIN & Std. SVHS jack. Size: 8"Dx6.5"H. Serial port (COM 2) software is provided. Std. rs232 serial cable not supplied. The unit does self test on power up and the video is active. Reg price over $4K **VERY Limited QTY, SONYPAL......$249ea.**

ULTRA MINI and WEATHERPROOF, "LIPSTICK" CAM

Sleek black anodized, alum. housing, O-Ring sealed & RAINPROOF. Adj. tilting mount. 1/3" CCD, 380 Lines, 0.3 Lux, AGC, Auto Shutter. 9-12VDC @100mA, 4mm, f1.8, 78° FOV real glass lens, NTSC video. <1ounce! IR SENSITIVE. 23mmdX50mm, 36" cable with BNC video & DC barrel jack.

GM-200K, PINHOLE Model. So tiny you can install it directly into a door. Only a 0.9" diameter hole! Specs as above. 90° FOV Pinhole lens. 1/2 once! Size only 23mm d.x35mm long. Think of the places you could put this little jewel.

GM-200K-STD...........$99
GM-200K-PH lens.....$99

MINIATURE FLUID PUMP is SELF PRIMING, OKEN SEIKO, type PO5G21

Industrial quality, mini pump. The 0.15" O.D. input and output ports are located on the top. A direct drive 12VDC motor draws about 250mA in operation and is an integral part of the pump. Pumping volume is about 5mL / sec. or about 10 oz. in about 60 sec. Overall size: 27mm d x 68mm H, with solder terminals for power. We are including 6ft. of new m,odical grade tubing perfect for use with the pump. Provides enough pressure to spray through a typical aerosol nozzle. Removed from new equip.

Special, PUMP-PO5G21....$7ea. or 5 for $29

GEAR MOTOR, METAL CONSTRUCTION, HIGH TORQUE, BUEHLER PRODUCTS, type 127K01880

These are brand new, very rugged gearmotors. They offer a 5mm diameter x 9mm long, flatted output shaft, located off-center (approximately 10mm from the edge of the 35mm diameter gearbox.) Overall size: 35mm d x 73 mm L (including the shaft) with 2" red and black leads. The motors are rated at 17VDC nominal and provide the following speeds:

@VIN	I NOLOAD	RPM
12V	60mA	360
15V	62mA	457
17V	64mA	523

Limited Quantity, BUEHLER 127K.........$12ea. or 3 for $29

MINIMOTOR SA, SWISS GEARMOTOR, Soooo TINY

State of the art "ironless" type, mini motor. Model: 1219E-012G-400. Includes a 104:1 Planetary gearbox. Size: 12mm d x 44mm L with 2mmd x 6mm L, flatted shaft, solder terminals.

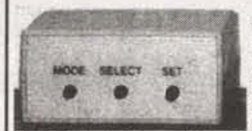
@VIN	IN	RPM
6V	5mA	68
12V	5mA	145

LIMITED QUANTITY
TYPE A: $22ea. or 5 for $99

AN INTERESTING DEVICE, "Quite handy with the ladies"

BOURNS type 3682S-1, "Digital Potentiometer" A two decade unit with + and - pushbuttons for inreasing the ohms from 1K to 100K in 1K steps! Super 1% accuracy. Snap in panel mount requires no hardware! Size: 1"w x 0.8"h x 1.2"d. It's like a mini decade box. Solder Terms. **New, $10ea. or 4 for $39**

NEW, BY POPULAR DEMAND, Universal Time and Date generator. Provides camera ID too!



Type TG-060, is only about the size of a pack of cigarettes but solves the problem of time stamping and identifying any video signal. Has RCA jacks for video in and out. Operates from 12VDC, AC adapter included. Super simple 3 button operation. Rugged plastic case with Velcro strip for easy placement. Brand New.

SPECIAL...$49ea. 2 for $89

ULTRA RESOLUTION & HIGH SENSITIVITY, SCIENTIFIC QUALITY CAMERA for demanding applications.

Type GM-6000, offers 410K pixels, 570 Lines resolution, < 0.1 LUX sensitivity. >45db s/N with AGC off. Access to all operating parameters from outside the camera! C or CS mount. Adjustable shutter speed from 1/60 to 1/100000sec, BLC on/off with adjustable area weighting, AGC on/off, gain, auto/off., Auto iris selectable, DC/Video with level control, external/internal sync. 24VAC powered, adapter included. Video out on BNC. Industrial quality metal housing.Just the thing for scientific or low light. Mention our web site and get a 12mm C-Mount lens free with camera.

APRIL SPECIAL, GM6000......$199ea.

NEW! LCD COLOR, TFT, ACTIVE MATRIX DISPLAY Offers a super 5.6" VIEWABLE AREA. Pro System Available with Custom Case, BUILT-IN 12V GEL CELL, all A/V cables and charger. Super Deal.

You asked for it. Finally we found a unit with exceptional quality at an affordable price. Perfect as a portable, general purpose color monitor for standard NTSC color or B&W video systems. Fully compatible with all our cameras as well as Camcorder, VCR's etc. Perfect as a rear view system with any video camera by virtue of its built in, mirror image function. Completely enclosed unit has adjustments for color, contrast and brightness and volume, for it's internal stereo speakers! A std. 1/4 x 20 Tripod socket and a tilt down stand for table top viewing. Inputs include: audio (L&R) and video on std. 1/8" mini jacks. External 12VDC on std. barrel connector. Specifications: 5.6", TFT active matrix LCD with 76.8K Pixels, CCFL backlight with 270cd/m Luminance, 500mW audio output available on std. 1/8" jack. 12V@600mA powered, 50mV min. or std. line level audio input. Overall size: 6.4"W x 5.25"H x 2.2D" New first quality. An optional accessory kit is available which includes: A luggage quality, custom made, padded case with dual removable straps for shoulder and/or holding at waist level for portable, hands free viewing. Built into the case is a 12V Gel Cell, rechargeable battery. Also supplied is a complete set of A/V cables. AC power adapter, power switch and battery charger.

GM-TFT56, with AC power adapter.....$299ea. GM-ACCYTFT......$45

NEW, "COLOR STEALTH CAM", MICRO SIZE, with AUDIO!

That's right! COLOR! In the same size package too! Sleek aluminum housing fits like a glove! Removeable mtg. bracket & a 1.3M cable with BNC vid., RCA aud., (internal mic) & DC pwr. jack for, no sweat hook up. Why fool around with an open P.C. board? Now you can have the "COLOR STEALTH CAM"

- 1/3"
- 350 Lines
- Auto Shutter
- 270k pixels
- Focus:10mm to inf.
- l<ounce!
- 0.7 Lux
- AGC
- Pwr. 6-12V @30mA
- Std. 7 mm, 56° FOV lens
- NTSC video
- Size: 31mm sq. x 28mm d.

GM-4000S-STD w/audio SPECIAL $89...

B & W "STEALTH CAM", MICRO SIZE, with AUDIO!

The sleek aluminum housing fits like a glove! Removeable mtg. bracket & a 1.3M cable with BNC vid., RCA aud., (internal mic) & DC pwr. jack for, no sweat hook up. Why fool around with an open P.C. board? Now you can have the "STEALTH CAM"•1/3" CCD •410 Lines•0.3 Lux• AGC•Auto Shutter• Pwr. 12V @110mA•250k pixels•Std. 4mm, 78° FOV lens•Pinhole, 90° FOV• Focus:10mm to inf.•NTSC video•<ounce!•IR SENSITIVE•Size Std: 30mm sq. x 29mm d. PH: 16mm d, Don't confuse with LOW RES., HIGH LUX C-MOS CAMERAS. ***GM-2000S-STANDARD OR PINHOLE,***

SPECIAL...$69ea.

NOW YOU CAN SEE WHAT THE "FISHES ARE DOIN' (down 60 ft.) UNDERWATER B&W CAMERA with INTERNAL, INFRA-RED ILLUMINATOR!

Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF. Adjustabe mount incl. Specs: 1/3" CCD, 400 Lines res., 0.05 Lux sensitivity, AGC, Auto Shutter. 12VDC @225mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. SENSITIVE to IR. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Perfect as a remote aresa inspection camera. Great for general outdoor use as well. **GM-300KIR.......$179**

NEW, GM960 TIME LAPSE VIDEO RECORDER

Finally a brand new, 4 head, T/L recorder with all the features at a price you can afford. Features: • Up to 960 hours on a standard T-120 VHS tape.• 12 different modes for record and playback • Audio recording in the 12H and 24H mode. • 30Day memory backup • Easy mode setting.• On- screen menus • Auto-Repeat recording mode • Serial or One-shot recording • Time, Date, speed, and Alarm indicators on screen. These deluxe units are front loading and are 14"W x 3.5"H x 12.2"D, 110VAC powered.

APRIL SPECIAL SPECIAL......$599ea.

TEKTRONIX 2465, 4 Chan., 300MHz, O'Scope, With on screen waveform stats

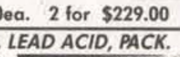
One of the most popular & powerful scopes available at a reasonable cost. Features: 500ps/Div sweep, 2mV/Div. vertical sensitivity, 1Mohm / 50-ohm input, 500Mhz trigger bandwidth, four channels. On-screen waveform cursors provide vert. & horiz. scale factors, trigger level, voltage, time, freq., phase, ratio values and mode indication. Complete with 2 probes, and manual. Excellent condition. 90 day warranty. **Very Limited Qty..............$2195.**

PORTABLE MINI PRINTER, 40 COLUMN, with INTERNAL NI-CAD POWER! The model SD222-1000 is a NEW & very cool, self contained, alphanumeric, impact printer. Standard parallel port, internal Ni-Cad power supply. Can be powered via the 9VDC pwr. adapter supplied. Standard 2" paper and Epson ERC-09 ribbon (included) both available at Staples etc. Has self test & diagnostic mode. Can emulate Epson and Citizen 560. It will print from the LPT port of your PC. Very rugged & well made. Perfect for remote printing or data logging application. Size: 8"L x 4.1"W x 3.5"H. STD. **OUR PRICE.......$49ea. or 2 for $75**

NEW, 9" SECURITY MONITORS, Hi-resolution, 700 Line, B&W units. 90 day warranty. BNC video in and loop through. Rugged steel case. Current production model. Limited qty. They will make your video look super!

SPECIAL...$119.00ea. 2 for $229.00

10V @ 2.5 AH SEALED, LEAD ACID, PACK.



Each pack has 5, 2 Volt cells. 'D'size cells are arrainged as 1X5 cells. Enclosed in an ABS outer shell. (removed for photo) Perfect for high drain applications. Make custom packs of any rating. Size: 7.5"L x 2.8"H x 1.5"D

SALE! 6-five packs for $20, 40 for $99

6V@12AH SEALED, RECHARGEABLE, BATTERY

New Panasonic, LCR6V12P1. Tough to get at a discount. Very compact. Two top mounted 1/4" faston connectors. Perfect for high drain projects. Size: 5.9"L x 3.7"H x 1.9"D

2 for $20, or 10 for $89

END FIELD of VIEW GUESSWORK! 3.5 to 8mm VARI-FOCAL LENS

Brand New, super f1.8 lens allows you to smoothly adjust from a 97 °FOV @ 3.5mm to a 44° FOV @ 8mm. Now you can frame your area of interest just the way you want it! Standard CS-Mount with adjustable focus and iris. **SPECIAL....$79ea. or 2 for $149**

SUPER, MINI C-MOUNT CAMERAS, Super sensitive, GM410 or the general purpose GM412, The GM-412 specs: B&W, size 1.5"sq. X 2.4"L, 250,000 Pixels, **380** Lines Resolution, Sensitivity **0.3** Lux, The GM410 specs: size only 1.5" SQ. x 1.6"L, >270,000 Pixels, **410** Lines Res., Sens. **0.05 LUX.**, Both cameras are 1/3" CCD with AGC & Electronic shutter. 12V @110mA power. NTSC out. IR SENSITIVE, BNC video out, Both use std. DC pwr. jack. Aluminum housings with dual threaded top and bottom mounting. True performance not hype! These cameras will outperform ***ANY*** camera in this magazine. Multi- lens options are available to exploit their superior performance. GM412 shown bottom. GM410 shown top. Prices are less c-mout lens.

GM412......$119, GM410.......$169

WORLDS SMALLEST ••• 100mW ••• VIDEO TRANSMITTER, ON SALE

Incredibly only 0.9" x 0.8" x 0.37" Transmits crystal controlled hi-res. images with 100mW output! The transmitter you've been waiting for. **Shown actual size.** Much smaller than the 9V battery which powers it. Draws only 35mA! Factory tuned. Receive on cable channel 59. Will work with color or B&W cameras. UHF Bow tie antenna with balun and 3' F cable for TV Included. Perfect with our GM1000A. **SPECIAL TVX-100.....$159. TVX100 with GM1000A CAMERA....$209.**

CO2, 120Watt CW, SEALED GLASS LASER HEADS Integral Hard Sealed Mirrors, NEW!

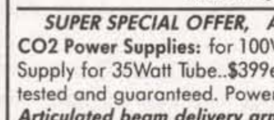
High quality water cooled heads. Were originally designed for medical application. All models are similar in construction. Size of the model 103: 60"L x 3.2"diam., Model 160: 44"L x 3.2"diam. Model 135: 35"L x 3.2"diam. Power requirement, model 103, 40KV trigger with 25KV @ 10 to 30ma operating current. Model 160 and 135, 30KV trigger with 15-20KV @ 7 to 20mA operating current. These are not toys. They must conform to Class IV CDRH regulations when assembled into a functioning system. Perfect for engraving, cutting and drilling most materials. Only three available. We don't expect any more.

Limited Qty...100+Watts.....$1475., 35Watts.....$895.

SUPER SPECIAL OFFER, ACCESSORIES to COMPLETE YOUR CO2 SYSTEM!

CO2 Power Supplies: for 100Watt+ Tube..$495ea. Supply for 60Watt Tube..$449ea. Supply for 35Watt Tube..$399ea. Power supplies are removed from equipment, tested and guaranteed. Power supplies are not sold without laser tube purchase. ***Articulated beam delivery arm with hand piece. Brand new. A fantastic item.with purchase of tube*** **.....$895ea. Arm without laser tube.........$1295ea.**

HP 6024A, AUTORANGING POWER SUPPLY, Efficient, compact and light weight.



With output of 0-60 volts at up to 10 amps amps, 200Watts max. Ten turn potentiometers provide precise control of voltage and current. Output levels can be observed on separate voltage and current meters. Front panel adjustable OVP. Also protects from over temp. and high AC line. **Now.......$895ea.**

HP 6034A, AUTORANGING POWER SUPPLY, With output of 0-60 volts at up to 10 amps amps, 200Watts max. All digital with dual LED displays and GPIB interface. Rack mountable. Front panel adjustable OVP.

Now.......$1495ea.

NEW! NOW YOU HAVE COLOR (down to 60 ft.) UNDERWATER.

Built-in WHITE LIGHT LED'S, Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF. Adjustable mount incl. Specs: 1/4" CCD, 350 Lines res., 0.5 Lux sensitivity, AGC, Auto Shutter. 12VDC @120mA,4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Perfect as a remote area inspection camera. Now with six super bright, white LED'S! BRAND NEW, **GM-400KW-LED.......$219ea.**

NEW WEB SITE NOW ON-LINE

WWW.RESUNLTD4U.COM

PLEASE VISIT TODAY

RESOURCES UN-LTD.

VISA, MC, AMEX, DISCOVER, COD, ON-LINE
ORDER: 800-810-4070 TECH:LINE 603-668-2499
FAX: 603-644-7825 EMAIL sales@resunltd4u.com
300 BEDFORD STREET, MANCHESTER, NH 03101

Write in 76 on Reader Service Card.

Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts readers* and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 92879, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

I'm designing a device to provide some data while I'm bike riding. I think I've figured out speed, acceleration, and distance.

I'm looking for a way to measure grade — how steep a hill I'm going up. Is anyone aware of a sensor, or other way to measure this?

4001 **Jeffrey Schwartz**
Orange, CT

How is the current held reasonably constant in MIG welders?

I've got everything I need to put one together, but I can't figure out what is needed to achieve the constant current requirement. Transistors, SCRs, or what? And with what circuitry?

4002 **Nick**
via Internet

I need a circuit that will interface with a PC-type keyboard and display on an LCD display the characters typed.

4003 **Jeffrey Thompson**
Lennox, CA

I would like to build a circuit to control a 300-400W water heating pad for a king-sized waterbed for maximum economy without causing the water temperature to fluctuate more than ±3° F.

4004 **James P. Koch**
Memphis, TN

I need information on cable TV cable connectors. I am not sure how to tell the difference between various types of CATV cables and their connectors.

I have a 15 ft. cable (not sure what kind) running from a wall jack. I attempted to install a RadioShack CF-56 connector to one end so I could hook it up to my VCR. After crimping and screwing the cable to the back of my VCR, the signal was dirty.

4005 **Bryan Murphy**

Several years ago, one of the progjects in the RadioShack 101 projects kit was a radio-powered radio. It consisted of two receivers: One tuned to the strongest local AM station and then converts the signal into a useful current to power the second receiver. How did it work?

In back issues of *Nuts & Volts*, I have seen readers making reference to this type of converting circuit for their low-power projects, but no how-to info was offered.

I have been looking for the RS schematic, plus other similar plans, books, etc., with no real success. Could be I don't know what to look for. I can sure use a good starting point.

4006 **Verl Wooters**
Centralia, IL

I am seeking some help on a Ultrasonic cleaner. The part I need the most help with is the oscillator to produce 40 to 60 KHz 1,000V sinewave to the piezoelectric transducers. I have a 1,000V transformer (1,500mA) with 110 VAC input.

4007 **P. W. Carnahan**
Marietta, GA

I want to build a simple RF power amp. The approximate specs would be 12 VDC, a few hundred micro watts in, 3-5 watts out.

For years, I have looked for a simple schematic for a simple single or maybe two transistor amps that will amplify up to about five watts in the 30 MHz to 100 MHz range.

Is there a schematic that's simple to build, using only a transistor or two, a few caps and coils, no baluns or transformers?

Please provide values and transistor number.

I currently have a Ramsey LPAI kit. It works but is too weak and it has to bread a frequency range.

4008 **J. B. Young**
Burgin, KY

I want to run the feed from my satellite dish about 150 feet under the lawn, but I have been unable to identify the types of coax that are suitable for burial. Is there some marking (like the UF for power cables)?

None of the references I have on coax mention burying the cable. Why?

4009 **Don Paul**
Clovis, CA

I have a Radio Plus FM sub-carrier tuner, manufactured by Fox Marketing or Fox Technology of Dayton, OH. It was manufactured in the "7th" year, so 67 or 77?

There is a potentiometer, and a 10-pin dip switch to tune in channels. I can tune in several different stations and sub-carrier channels, and I've made several comparisons from dip settings to the frequencies, but I can't make heads or tails of how the dip switch settings relate to the channel frequencies. Any suggestions?

4010 **Steve Crabb**

I am wondering how to make a 555 timer circuit that has an adjustable speed, and can still maintain a 50/50 duty cycle on pin 3 (the output). Having a 50/50 duty cycle is the easy part, but I don't know how to make it adjustable by using a trimmer pot.

Can anyone draw me a diagram?

4011 **Ray Samples**
Fayetteville, NC

ANSWERS

ANSWER TO #2001 - FEB. 2000

Need to add an analog S-meter to my portable AM/FM radio for AM reception only?

The simplest solution is to measure the automatic gain control (AGC) signal derived from the AM detector diode. This signal may be positive going or negative going depending on the design.

You will need an oscilloscope and a bit of Ohm's Law to study the change in the voltage from "no signal" to a very strong station and calculate a resistor divider string to operate whatever meter you plan to use (50uA, 200uA, 500uA). An LED bargraph driven by an LM3914 (or two) would be straight-forward and look very sharp.

If the bias at the detector diode is a problem, take a look at Mr. Russell Kincaid's isolation circuit in the Jan. 2000 issue of *Nuts & Volts* on page 27.

Robert Miller
Trenton, NJ

ANSWER TO #20015 - FEB. 2000

I need to configure a roof-mounted antenna distribution system that piped both AM/FM signals over the same 100 ft. coax to be distributed to six outlets using a RadioShack auto antenna preamp.

I am looking for a better way to combine amplified AM/FM signals so there is plenty of signal to work with at the other end.

Your problem is similar to the ones in CATV systems. Unfortunately, the inexpensive CATV components do not work in the AM band, so you must look at other suppliers such as Minicircuits or make your own.

Many configurations are possi-

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be sent if your answer is printed. Be sure to include your mailing address if responding by E-Mail.
- In most cases, only one answer per question will be printed.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
- The question number and a short summary of the original question will be printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

QUESTION INFO

TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:
1) Circuit Design 3) Problem Solving
2) Electronic Theory 4) Other Similar Topics

INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

TECH FORUM

ble. The first problem is the antennas. An FM antenna covers a 20% bandwidth, so its output impedance can be reasonably constant.

An AM antenna must cover more than an octave, and the wavelengths are impracticably long (about 300 meters).

The AM antenna will offer a poor match to a transmission line. The saving grace is the band is very noisy, so a poorly matched antenna can work. Some companies, such as Rohde and Schwarz, sell active antennas that might solve the AM/FM reception problem in one step.

If the RadioShack preamplifier is designed correctly, it would have an output impedance of 75 ohms and could drive a coax cable of arbitrary length. Your comments about a 46 inch cable and coupling with two capacitors is discouraging. If the design can tolerate a 3dB loss, then AM and FM signals could be combined with a power splitter/combiner. If that loss is unacceptable, then the design should use a diplexer.

A diplexer is a combination of a lowpass filter and a highpass filter, the filters are connected together at the common port. The cutoff of both filters is set at the geometric mean of the desired band edges (in your case, the geometric mean of 1.6 MHz and 88 MHz = 11.9 MHz). Both filters are designed to be reflective in their stop bands (i.e., they look like an open circuit).

The lowpass filter should connect to the common port with a series inductor, and the highpass filter should connect to the common port with a series capacitor. (The suspicious RS preamp used two capacitors, but they might be DC blocks.)

If the filters are 75-ohm single L sections, then L = 1.4uH and C = 126pF. Multiple section filters are used in satellite TV diplexers.

The amplifier can be a big problem because strong signals can mix together to form intermodulation products that interfere with weak stations.

The amplifier must be linear, and that requires good design and lots of power. The amplifier for an active

ANSWERS TO #3007 - MAR. 2000

I have a pretty good dissecting microscope and I would like to be able to project images of material on the microscope stage onto a TV B/W screen. Where does one get a "relay lens system" and a C- mount camera?

#1 If your microscope already has a C-mount video port, all you might need is a video head. Depending on your setup and resolution requirements, they could be B&W security-type to high-end scientific.

There are also mounts that have microscope eyepiece adapters such as the Videoflex http://www.focuscorp.co.kr

http://geologyone.com/cameras.htm looks to be a good source to find the proper adapter or http://www.videolabs.com/

If you don't have the C-mount and want to keep costs as low as possible, I would consider a lipstick or board camera and building a boot to go over the eyepiece.

The mere mention of a lens relay system seems to equate to places that don't list prices.

Will your B&W TV work with the setup?

Most cameras output via a RCA video connector ... if the TV is old it lacks a RCA video in, then you'll have to spend $20-$30 for an adapter available at sources such as RadioShack to make things work together.

Ed Bell
Colchester, VT

#2 Edmund Scientific, 101 East Gloucester Pike, Barrington, NJ 08007-1380, sells relay lens systems. You can get their Optics and Optical Instruments catalog by calling 609- 573-6250.

My catalog is two years old, so the prices and catalog numbers are stale.

The purpose of the relay lens system is to send the image from the microscope onto the camera's image sensor. There are two types of systems.

The replacement-type relay lens replaces the microscope's eyepiece; it fits into the microscope barrel (23mm in a DIN microscope; most microscopes are DIN standard). In the replacement-type system, the relay lens has some optical gain (a typical eyepiece might have a 10X gain, and this gain is lost when the eyepiece is removed).

Edmund has a replacement-type microscope video relay lens, stock number F37820, for $230.00 (1998 price).

The second type is the thru-type relay lens. The thru-type fits over the existing eyepiece. Edmund's thru-type microscope video relay lens, stock number F39925, is $230.00 (1998).

Both relay lenses expect a video camera with a industry standard C-mount, which is a 1"-32TPI threaded mount.

Most video cameras with interchangeable lenses use a C-mount or a CS mount. CS stands for a "shortened" C mount. You convert a CS mount to a C mount by adding a 5mm spacer (thus lengthening the shortened mount). Many CS mount cameras come with the 5mm adapter.

There is nothing particularly special about the video camera. I'd pick one up on the surplus market, and there are several dealers in *Nuts and Volts*. A black and white camera should be less than $100.00. Find a small camera to keep the bulkiness of the assembly down.

The output of the camera should be an NTSC signal, and it will drive a video monitor directly.

Most modern TV sets have a video in port (usually an RCA jack) that will accept the NTSC signal. If your TV doesn't have a video in port, then you need an RF modulator. You can find them, but it might be less trouble to buy a newer TV or use the RF modulator in a VCR.

Gerald Roylance
Mountain View, CA

ANSWER TO #20017 - FEB. 2000

Need a pulse train transmitter circuit that operates on a frequency of 230 MHz.

This oscillator followed by a two-stage limiter should do the job. The 1K pot should give some control of pulse width, although a fixed 1K to a variable voltage source would be more effective.

The diodes prevent Q2 and Q3 from saturating which would allow charge storage and stretch the turn-off time.

The parts are all available from RadioShack.com

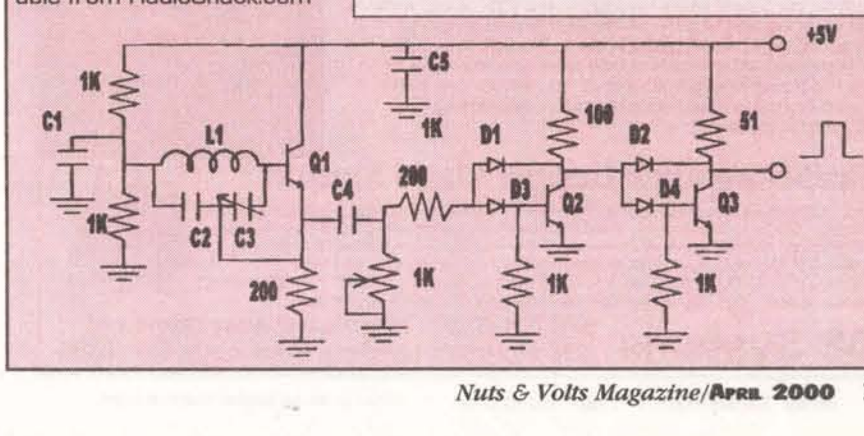
Parts list:

C1, C5	1,000pF disc ceramic	900-2216
C2, C4	47pF disc ceramic	900-2197
C3	10pF trimmer	900-5849
Q1	2N5179	900-5450
Q2,	Q3 2N5109	900-5451
D1,	D2 1N5711	900-5686
D3,	D4 1N4148	900-2908
L1	55nH eight turns #30 wire on 0.1 inch dia. resistor of 1 megohm or greater	

The resistors may be 1/4 watt except the 51 ohm should be 1/2 watt.

I have not built this, so some tweaking may be required.

Russell Kincaid
Milford, NH



antenna can take 10W. The amplifier should not have a lot of gain because that aggravates the intermodulation distortion. Too little gain loses the weak stations in the noise.

Sometimes you cannot win. Some (older) CATV installations use filters and attenuators to equalize all stations to the same power level.

The coax cable has little loss at these frequencies, so it should not be a problem. For foam cable, the loss per hundred feet in the AM band is about 0.4dB, the FM band loss is about 3dB.

At the tail end, you can use a combination of power splitters and directional couplers to provide the signal taps. Power splitters are the simplest solution if a cable must branch in different directions. They also provide higher signal levels.

If you need to serve a string of offices, then directional couplers make sense. The main cable would run by each office and terminate in a resistor, each office would have a 10 to 20dB directional coupler and a drop cable. A 20dB resistive tap could also be used — that is just a 680-ohm series resistor.

All of the taps should be terminated, but the power splitters and directional couplers minimize the effects of reflections. I would use diplexers on the tail ends to control reflections and avoid overloading the receiver's front end, but that is probably overkill.

Gerald Roylance
Mountain View, CA

ANSWERS TO #3004 - MAR. 2000

Can someone give me a simple circuit design that will track the sun for a solar panel and tracking sound?

#1 The basic idea of a tracker is simple. You need two sensors (left and right) and a difference amplifier. If the left sensor is getting more light than the right sensor, then the difference amplifier says turn left. If the right sensor is getting more light, then the amplifier says turn right.

The tracker is a servo system, so the loop gains and the frequency response of the positioning system come into play.

The sensors require some thought, too. Typically, one lens focuses the image onto two side-by-side sensors, and the target image must be smaller than the sensor area, but larger than the gap between the sensors. Some pyro detectors are well-suited for this application.

Altitude-azimuth tracking uses a 2x2 sensor array. The azimuth drive compares the two left sensors against the two right sensors. The altitude drive compares the two top sensors against the two bottom sensors.

Getting initial lock can be a problem. If the sensors have a narrow field of view, then they must either scan for the target or wait until one happens by. If the target can turn off, then there are more problems.

Tracking sound can be done the same way, but the directional microphones can be challenging. In the long run, it is probably easier to cross-correlate the left and right channels and calculate the sounds angle of arrival.

Addressing the solar panel issue, you probably do not want to make a solar tracker. Yes, you can gather more energy with a solar tracker, but the question becomes is the added complexity worth the added gain? The tracker requires more parts and motors, and they add cost and maintenance headaches. If you need more power, it may be cheaper to increase the size of the array. Consult a book on solar energy and read about optimizing the (static) tilt angle of the array.

There are some interesting observations about the sun's angle and intensity. The sun is brighter (in the northern hemisphere) during winter, but the days are shorter. If the system works during the (cloudy and overcast) winter, then making it work during the summer is easy.

If you still want to position the solar arrays, don't bother building a tracker. Just calculate the position of the sun and point the arrays accordingly. A solar tracker would have a hard time tracking during overcast days, and something needs to return it to the east for a new day.

If you calculate the position of the sun, then none of those problems arise.

If your solar array is photovoltaic, then you might want to add a power tracker — a device that extracts the maximum amount of power from the array.

Gerald Roylance
Mountain View, CA

#2 This tracking circuit follows the sun. If you are more specific about what you are doing with sound, I can come up with a circuit.

There are two photo transistors. When both see the sun or it is dark, the drive motors do not move. When one photo transistor is shaded, the other one turns on a motor to drive the unit until both see the sun.

Here is how it works: The exclusive-or (7486) output will be high when either input is high, but not both. When both inputs to the 7486 are high or low, the output will be low. The 7402 is a quad NOR gate, but I used one as an inverter and two as inverted AND gates.

The 7402 output will be low when either or both inputs are high, and the output will be high only when both inputs are low. This truth table will show the logic:

A	B	C	-C	D	E
H	H	L	H	L	L
L	L	L	H	L	L
H	L	H	L	H	L
L	H	H	L	L	H

The unused inputs should not be left floating, so I have shown one way to connect them.

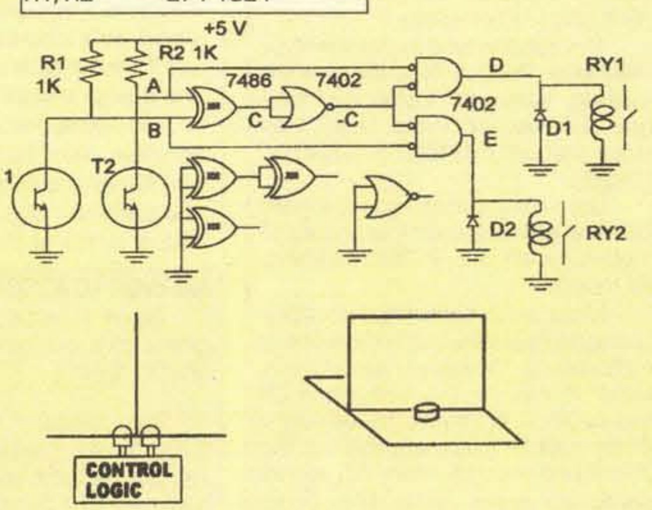
You can use 74, 74LS, 74ALS, 74HC, or 76HCT logic. The cheapest is best. RadioShack doesn't stock the '86, but you can order it.

The relays can handle up to 1 amp. If the motors are large, use these to drive larger relays.

The parts list is all RadioShack parts.

Russell Kincaid
Milford, NH

Parts List	
74HC86	RSU 12168639
74HC02	RSU 10880045
T1, T2	276-145
RY1, RY2	275-232
D1, D2	276-1101
R1, R2	271-1321



ANSWER TO #20018 - FEB. 2000

What is the best way to build a 15- or 20-watt tube amp for a guitar?

Tube amplifiers are highly overrated, their only advantage is that they don't sound as bad as transistor amplifiers when overdriven.

Transistor amplifiers are more reliable, give as good or better fidelity, and are cheaper. So, instead of building a 20-watt tube amp and overdriving it, buy a 50-watt transistor amp and don't overdrive it.

The quality of the sound from any amplifier depends almost entirely on the quality of the speaker, so don' skimp there.

Russell Kincaid
Milford, NH

ANSWER TO #20019 - FEB. 2000

When I record on a chip and move the pentometer during play-

Continued on page 84

CALL TOLL FREE

(800) 292-7711
Orders Only

Se Habla Español

C&S SALES

Secure On-line Ordering @ cs-sales.com

CALL OR WRITE FOR OUR **FREE** 64 PAGE CATALOG!
(800) 445-3201

Digital Multimeters

Elenco Model M-1740

$39.95

11 Functions:
- Freq. to 20MHz
- Cap. to 20μF
- AC/DC Voltage
- AC/DC Current
- Beeper
- Diode Test
- Transistor Test
- Meets UL-1244 safety specs.

Model M-2760 - $24.95
(9 functions)

Elenco Model LCR-1810

$99.95

- Capacitance .1pF to 20μF
- Inductance 1μH to 20H
- Resistance .01Ω to 2000MΩ
- Temperature -20°C to 750°C
- DC Volts 0 - 20V
- Frequency up to 15MHz
- Diode/Audible Continuity Test
- Signal Output Function
- 3 1/2 Digit Display

Fluke 87III

$319

Features high performance AC/DC voltage and current measurement, frequency, duty cycle, resistance, conductance, and capacitance measurement.

CCTV Cameras

Cameras have 420 lines (380 color) of resolution, 0.08 Lux, 3.6mm/F2 90° field of view. Power requirement is 12VDC @ 100mA (order SC-1).

MONOCHROME CAMERAS

SC-12 - 35mm Lens (1.25"x1.25") $69
SC-15 - Pin Lens (1.25"x1.25") $69

Add $10 for lens • Add $10 for audio

Accessories:
SC-1 - 12V 100mA adapter $6.[00]
SC-2 - 50' cable with connectors $19.[00]

COLOR CAMERAS

SC-20 Pin Lens
SC-21 3.6mm Lens
360 Lines 1.25" x 1.25"
Infrared Sensitive, Audio Included
$109
Add $10 for case
Call for complete catalog.

Quantity Discounts Available

Test Equipment

Elenco Sweep Function Generator with built-in frequency counter Model GF-8036

$229.95

This sweep function generator with counter is an instrument capable of generating square, triangle, and sine waveforms, and TTL, CMOS pulse over a frequency range from 0.2Hz to 2MHz.

10 Function 1.3GHz Universal Counter Elenco Model F-1300

$229.95

- Frequency .05Hz - 1.3GHz 3 Ranges
- Period - Can read 60Hz to 60.000000 F=1/T
- Totalize - Counts to 199,999,999
- RPM - 3 to 2099994 RPM
- Duty Cycle
- Max/Min/AVG with Time
- Stop-watch set .2 sec. to 100 hrs.
- Math Functions
- Timer - 2 sec. to 99 days
- Pulse Width - 0.1ms to 66666.6ms

20MHz Sweep / Function Generator with Frequency Counter Model 4040

- 0.2Hz to 20MHz
- AM & FM modulation
- Burst Operation
- External Frequency counter to 30MHz
- Linear and Log sweep

$445

21.5MHz Model 4070	$1295
10MHz Model 4017	$325
5MHz Model 4011	$255

BK PRECISION

Elenco Handheld Universal Counter 1MHz - 2.8GHz Model F-2800

$99

Sensitivity:
- <1.5mV @ 100MHz
- <5mV @ 250MHz
- <5mV @ 1GHz
- <100mV @ 2.4GHz

Features 10 digit display, 16 segment and RF signal strength bargraph.

Includes antenna, NiCad battery, and AC adapter.

B&K Frequency Counter Model BK-1875

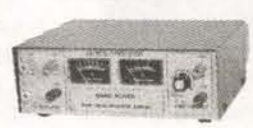
50Hz - 2.8GHz
3 Channels

$189

Sensitivity:
- <0.8mV @ 100MHz
- <6mV @ 300MHz
- <7mV @ 1GHz
- <100mV @ 3GHz

Ultra sensitive synchronous detector bargraph and RF strength.

Elenco Quad Power Supply Model XP-581



4 Fully Regulated DC Power Supplies in One Unit

$85

4 DC voltages:	
3 fixed:	+5V @ 3A
	+12V @ 1A
	-12V @ 1A
1 Variable:	2.5 - 20V @ 2A

B&K Video Monitor Tester Model 1275

$169

Great handheld unit to test PC and Mac monitors. The model 1275 is ideal for the field or the service bench. Small, portable and very effective, the 1275 generates crosshatch, dots, color bars and raster patterns in green, blue, red, black and white.

Soldering Station

Weller Low Cost Soldering Iron Model WLC-100

- Variable power control produces 5-40 watts.
- Ideal for hobbyists, DIYers and students.
- Complete with 40W iron.

$34.95

Elenco Oscilloscopes

Free Dust Cover and 2 Probes

UL

S-1325	25MHz	Dual Trace	$325
S-1330	25MHz	Delayed Sweep	$439
S-1340	40MHz	Dual Trace	$475
S-1345	40MHz	Delayed Sweep	$569
S-1360	60MHz	Delayed Sweep	$749
S-1390	100MHz	Delayed Sweep	$995

DIGITAL SCOPE SUPER SPECIALS

DS-203	20MHz/10Ms/s Analog/Digital	$695
DS-303	40MHz/20Ms/s Analog/Digital	$995
DS-603	60MHz/20Ms/s Analog/Digital	$1295

Tekk Radios

Pro-Sport FRS Two-Way Radio Model PRO-SPORT+

Talk up to 2 miles!

Available in Yellow, Blue & Black

No License Required

- 1/2 Watt Output, 14 Channels.
- TX & RX LED/LCD Indicators.
- Large LCD Display.
- 38 Privacy (CTCSS) Tones.
- Removeable Antenna.
- Water Resistant.
- 500mW Output.
- Palm Sized.

$69 each **or** **$125** Set of 2

PRO SPORT Model $109.95 set of 2

PC Repair

A+ Certification Self-Study Course™ Model XK-305

$379

DOS/WIN Exam
DOS 6.2
Windows 3.1 Installation and Configuration
Windows 3.1 Application Support
Windows 3.1 Devices and Drivers
Windows 3.1 Networking and Troubleshooting
Windows 95 Installation and Deployment
Windows 95 Basic Configuration
Windows 95 Troubleshooting and Optimization

Includes all the technical material, knowledge and interactive exercises needed to pass the A+ exams and excel in the competitive PC repair marketplace.

Introduction to PC Repair Self-Study Course™ Model XK-301

$179

COURSE CONTENTS

Introduction to Computers	Introduction to Windows 3.1
IBM PC's and Clones	Introduction to Windows 95
PC Assembly/Disassembly	Introduction to Networks
Introduction to MS-DOS	Introduction to the Internet

Provides you with the easiest and most effective way to learn the fundamentals necessary for a profitable and successful career as a PC Repair Technician. Ideal for individuals new to the I.T. profession and as instruction prior to studying for A+ certification.

Elenco Technician Tool Kit Model TK-1500

$49.95

28 tools plus a DMM contained in a large flexible tool case with a handle ideal for everyone on the go.

Elenco Educational Kits

Model AR-2N6K

2 Meter / 6 Meter Amateur Radio Kit

$34.95

Model AM-780K

Two IC Radio Kit

$11.95

Model AK-700

Pulse/Tone Telephone Kit

$15.95

Model AK-870

$24.95

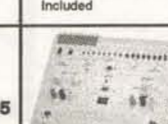
Radio Control Car Kit
- Solderless
- 7 Functions
- Radio Control Included

Model M-1005K

Digital Multimeter Kit
- 18 Ranges
- 3 1/2 Digit LCD
- Transistor Test
- Diode Test

$19.95

Model XK-150



Digital / Analog Trainer

$89.95

Guaranteed Lowest Prices

UPS SHIPPING: 48 STATES 5%
OTHERS CALL FOR DETAILS
IL Residents add 8.25% Sales Tax

SEE US ON THE WEB → http://www.cs-sales.com

C&S SALES, INC.

150 W. CARPENTER AVENUE
WHEELING, IL 60090
FAX: (847) 541-9904 (847) 541-0710

15 DAY MONEY BACK GUARANTEE

2 YEAR FACTORY WARRANTY

VISA MasterCard DISCOVER

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

Write in 77 on Reader Service Card.

by Homer L. Davidson

SMD Shortwave Receiver

You can listen to the latest world news on a Spanish Broadcast System of Madrid, Spain, BBC of the United Kingdom, and many religious broadcast stations here in the USA, with this small SW receiver.

The small SMD shortwave receiver can be tuned to the 41 or 31 meter band.

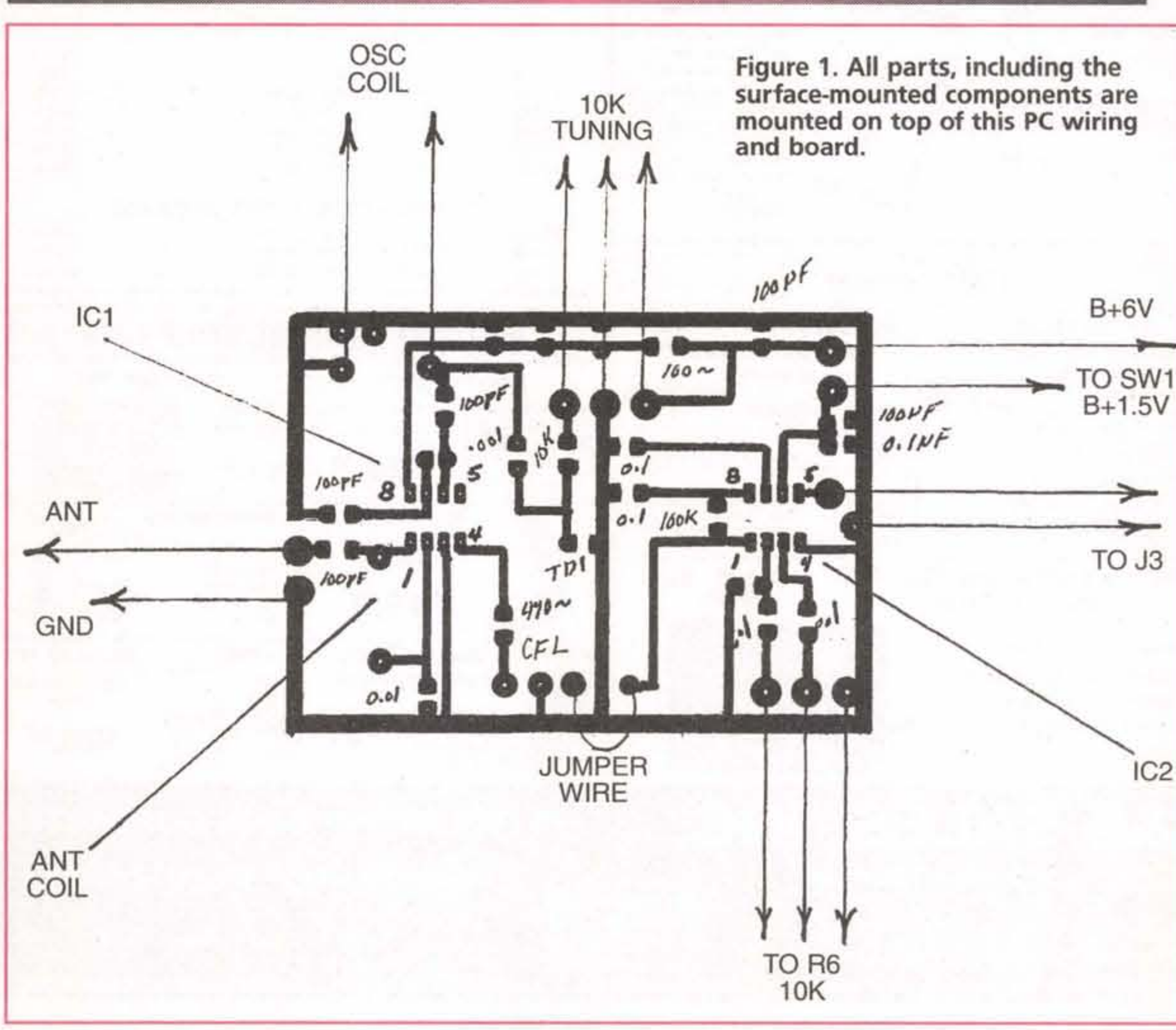


Figure 1. All parts, including the surface-mounted components are mounted on top of this PC wiring and board.

Besides foreign stations, you may tune in on a militia group or an unlicensed pirate broadcast station around 7.4 MHz. Although this tiny receiver was built for listening on the 40-41 meters, the set can be tuned to the 30-31 meter band. This SMD receiver may be very tiny, but it pulls in a large number of foreign broadcast stations (Figure 1).

Not only is it fun building an SW receiver, you can learn how to build electronic projects with those popular miniature surface mounted (SMD) components. All parts are mounted on a 2x2-1/2 inch PC board chassis with SMD parts, except the coils, ICs, and a 455KHz ceramic filter. Actually, CF1 is smaller than either IC. Only two eight-pin IC components operate in a superhet circuit. This small shortwave receiver should be connected to a 50-foot outside antenna, 25 feet off the ground for good reception.

Circuit Description

IC1 is a low-powered monolithic double-balanced mixer with input amplifier, on-board oscillator, and voltage regulator. The popular NE-602 operates as the RF, mixer, and variable frequency oscillator (VFO) in the superhet circuit. L1 operates in a balanced front end that provides broadband RF amplification with no tuning capacitor. The iron core RF coil can be a miniature molded RF (8.2uH) or choke coil (Figure 2).

The adjustable oscillator coil (4.60 to 8.50 uH) has an adjustable iron core and stands upright on the PCB. L2 can be adjusted for either the 30- or 40-meter band. Here you do not have to wind your own coils, they are commercial units. The iron core of the oscillator coil can be rotated with a regular plastic alignment tool. If not, the core can be broken and damaged so it will not turn at all. Pick up this alignment tool at RadioShack.

The foreign broadcast RF signal is picked up by the antenna, coupled to L1 terminals, and tied to pins 1 and 2 of IC1. The variable oscillator coil (L2) is tuned by a diode and selects the various stations. By placing a varying voltage upon the varactor diode (TD1), R3 tunes in the different stations. Actually, R3 takes the place of an air-tuned variable capacitor, which is quite expensive and difficult to locate. A large control knob or vernier dial can help separate the crowded shortwave band.

The resulting IF frequency (455KHz) is coupled from pin 4 of IC1 to pin 1 of IC2. CF1 is a intermediate frequency (IF) ceramic filter, that requires no alignment. IC2 is a 10-transistor, tuned-radio frequency (TRF) detector IC (like the Z414Z), with added buffer and amplifier. Here the RF section is used in the IF amplifier circuit. The internal audio AF circuits of Z416E were designed to feed into a low-impedance headphone (64 ohms), like those found in a small cassette player.

Although, Z416E IC was designed to work in a low audio amplification, without a volume control, R6 was tapped into the audio output (pin 2) and input of the pin 3 circuit. By adding another coupling capacitor (C10), R6 is isolated from pin 2 and 3 voltage terminals. The volume control must be lowered on the very strong foreign broadcast stations, for easy earphone listening.

Coil Data

L1 and L2 are both commercial-built coils that can be ordered from electronic mail order firms. L1 can be purchased for less than $1.00 and L2 for less than $5.00. L1 is a fixed 8.3uH iron core molded RF coil, while L2 is an adjustable 4.60 to 8.50 uH inductance. L1 terminals are cut real short and soldered directly to the PC wiring. L2 stands upright. All three terminals of L2 are bent at right angles for the mounting pads. Both coils were purchased from Circuit Specialists, Inc., 220 S. Country Club Dr., Mesa, AZ 85210.

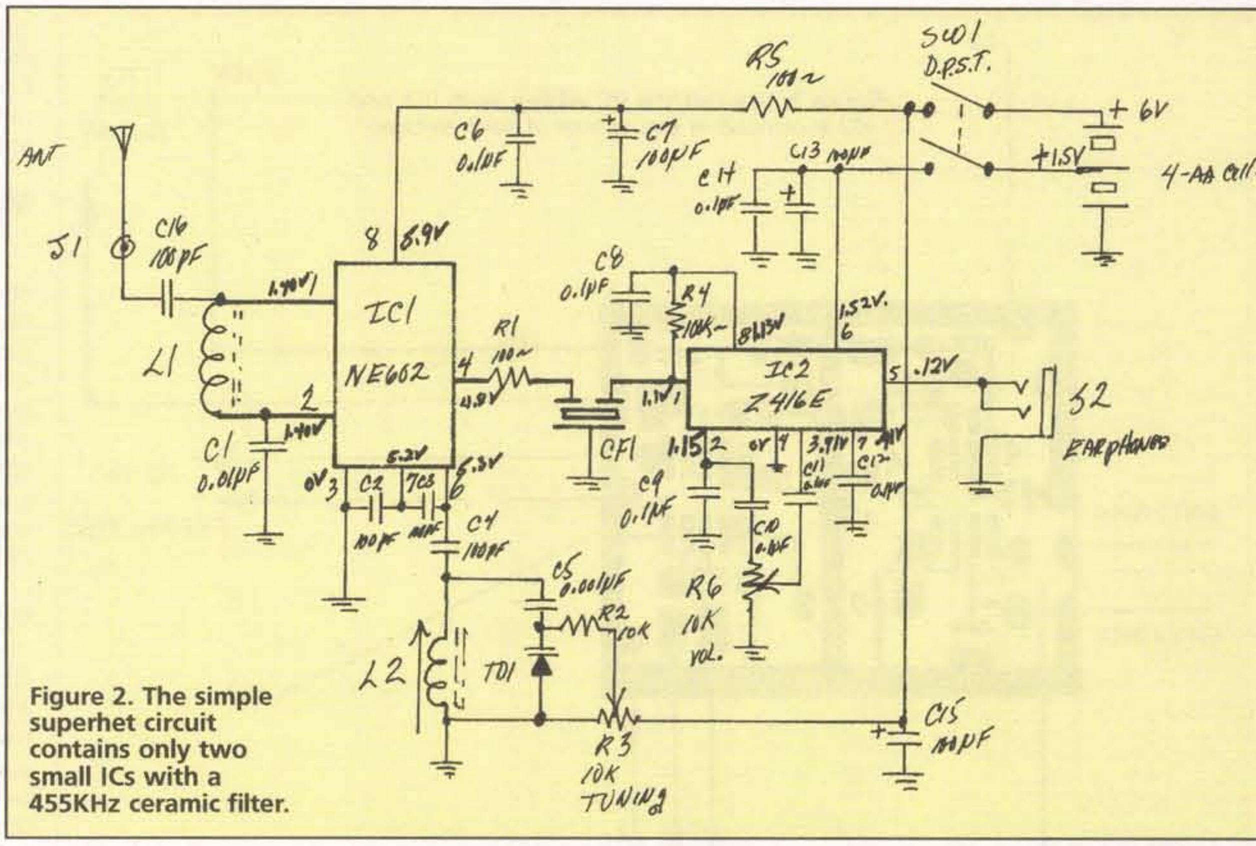


Figure 2. The simple superhet circuit contains only two small ICs with a 455KHz ceramic filter.

PC Board Layout

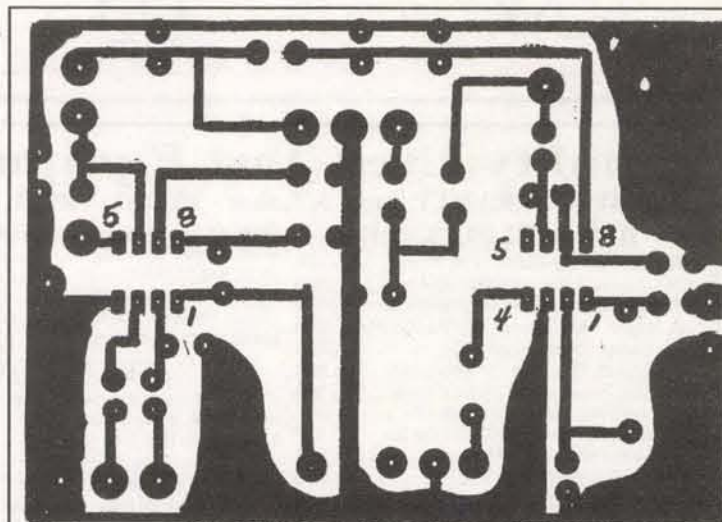
Cut the 2x2-1/2 inch PC board from a larger piece. Layout the PC wiring with direct etching dry transfer patterns. Extend the IC eight-pin transfers by placing another set upon the end of each pin terminal. This method will hold the IC terminals when they are bent outward. The same IC pad transfers can be doubled-up (back-to-back) for the tiny SMD mounting pads. The distance of these IC patterns is ideal for mounting the tiny capacitors and resistors (Figure 3). Both IC pattern terminals are placed in the middle of each section.

Place a wider layer of PC pattern clear around the audio and RF sections. Both RF and AF sections are isolated with a strip down the middle. Leave a small space in the RF section for the antenna terminal connection. Only two jumper wires are needed: one at the six-volt source going to pin 8 of IC1 and another at the IF output of CF1 to the input terminal 1 of IC2. These small jumper wires can be ends cut from regular resistors or capacitors.

After etching the board, place solder upon the copper wiring and wipe off excess with a cloth. Check all wiring terminals and pads so they do not touch. Double-check each IC terminal so they do not connect to one another. Cut out the copper pattern with a razor blade, if they are too close together. Clean off all solder flux around the SMD and IC parts with the edge of a pocket knife or small screwdriver blade.

SMD Component Selection

All components for the SMD receiver can be purchased locally or from mail order firms. IC1 (NE-602N) can be ordered from mail order firms, while IC2 was purchased at Kevin Electronics, 10 Hub Drive, Melville, NY 11747. Try to obtain all SMD parts at one electronic mail order firm. The SMD bypass and coupling capacitors are purchased in 5-, 10-, or 20-lot packages. These fixed SMD resistors and capacitors are mounted upon a plastic strip. The electrolytic capacitors can be purchased separately. These capacitors are much cheaper when purchased in a 10-lot package and can be used for other electronic SMD projects.



BOTTOM VIEW. Mount all standard parts upon the top side of this board as the PC wiring is found underneath like most PC wiring.

Do not purchase any electrolytic SMD capacitors with a working voltage under 16 volts. Sometimes a six-volt supply may break down or heat up an electrolytic capacitor with a 10-volt working rating. All bypass and coupling capacitors are of the 50-volt variety. Notice capacitors C2, C3, C4, and C5 are NPO 50-volt capacitors. The SMD resistors are

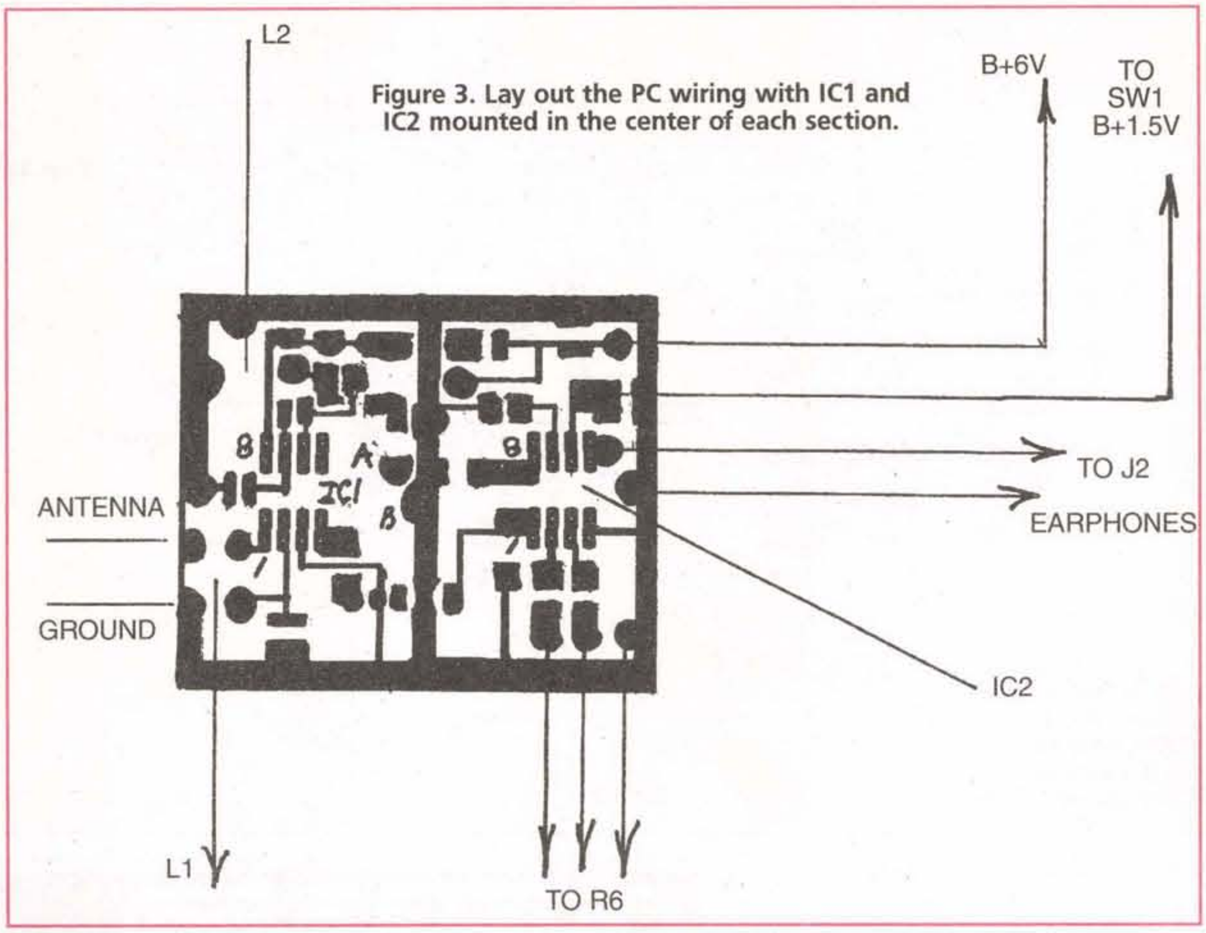
rated at 1/8 watt units. For instance, all SMD resistors, capacitors, and CF1 can be purchased from Digi-Key of Thief River Falls, MN. The necessary parts and where you can purchase SMD parts are found in the Parts List.

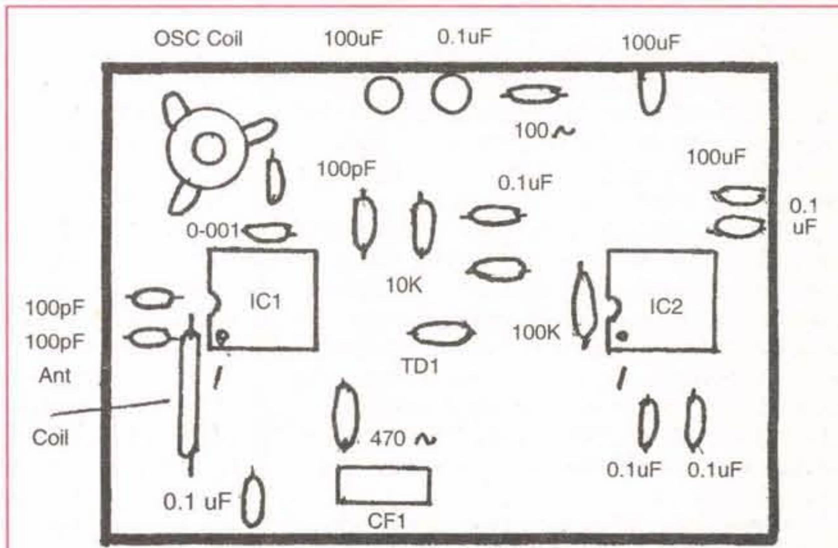
Mounting the SMD Parts

Double-check the capacitance and resistance of each part within a plastic package. Mark the microfarads and resistance upon each package, if not found there. Remove only one part at a time to solder into position, as these small SMD capacitors and resistors are not marked upon the top side. Peel back the plastic cover, push out the SMD part with a pocket knife blade or miniature screwdriver. Do this over a white sheet of paper. Remember, these tiny parts can easily be lost or dropped (Figure 4).

Place a bead of solder upon each pad where the SMD part mounts. Use small 0.031 or 0.021 thin gauge solder for these small connections. Only a dab will do. Where the SMD part straddles across the PC wiring (like C4 and R1), build the pad up a little higher, then place the SMD part upon pads and solder up. Use a pair of small tweezers to handle the small SMD parts. After soldering each component into the circuit, check for shorts across it. Test for correct resistance of each mounted resistor. Make sure the right part is soldered into the right pad. Hold the part with tweezers on the pad and place the small iron tip

Figure 3. Lay out the PC wiring with IC1 and IC2 mounted in the center of each section.





TOP SIDE OF THE BOARD. All standard components are mounted on top of the board with holes drilled through the board to the PC wiring.

Circuit Specialists, Inc.
220 S. Country Club Dr.
Mesa, AZ 85210
1-800-528-1417

MCM Electronics
650 Congress Park Dr.
Centerville, OH 45459-4072
1-800-543-4330

Digi-Key Corp.
701 Brooks Ave. South
Thief River Falls, MN 56701-0677
1-800-344-4539

Mouser Electronics
2401 Hwy. 287N
Mansfield, TX 76063-4827
1-800-992-9943/817-483-6828

Hosfelt Electronics, Inc.
2700 Sunset Blvd.
Steubenville, OH 43952
1-800-524-6464

Oak Hills Research
20879 Madison St.
Big Rapids, MI 49307

Jameco Electronics
1355 Shoreway Rd.
Belmont, CA 94002-4100
1-800-831-4242

Kelvin Electronics
10 Hub Dr.
Melville, NY 11747

Electronic Mail Order Firms

at the end of the SMD part to make a good bond.

First, mount IC1 and IC2. Bend the terminals out at a right angle so the ICs will mount flat over each pin terminal (Figure 5). Check for a white line or "U" indentation of IC for pin 1 of NE-602. Likewise check for a white dot on Z416E for pin 1. Make sure pin 1 of IC is over pin 1 of PC wiring. Solder pin 1 and then go over to the other side and solder in pin 8. Place only enough solder upon PC wiring for a good connection. Do not leave the iron on the pin terminal too long. Check for leakage between each terminal with the low-ohm scale of DMM.

Check each bypass and coupling capacitor across the terminals with a 200-ohm scale of the digital multimeter. A normal 0.001 to 0.1 uF capacitor will have a quick ohm indication and then an infinite reading. Test the electrolytic capacitors on the 20,000-ohm scale and watch the capacitor charge up and down, indicating no shorts or leakage and good SMD part connections. Test each part as it is soldered into the circuit and the SMD receiver will correctly operate when you are finished.

Testing Out

Double-check all SMD part connections with a magnifying glass. Make sure all ends of the SMD parts are covered with solder (Figure 6). Take a resistance measurement across the +6 and +1.5-volt source to common ground. If normal, only an infinite resistance measurement should be found on a 2K ohm resistance scale.

Temporarily, connect extension hookup wires to the volume control, antenna post, tuning control, and earphone jack. The correct length can be cut off after it is mounted in the cabinet. Make sure the common ground terminal of the stereo earphone jack is at ground potential. If not, when mounted in a metal cabinet, the audio will be grounded out with pin 5 of IC2 connection. Now solder wires to the +6 and 1.5 volt sources for testing. It is best to test the chassis out before placing in the cabinet.

Although, any small shortwave receiver operates best at night on a single long wire antenna, you can give it a test during the day. Plug in a pair of low impedance earphones. Connect the

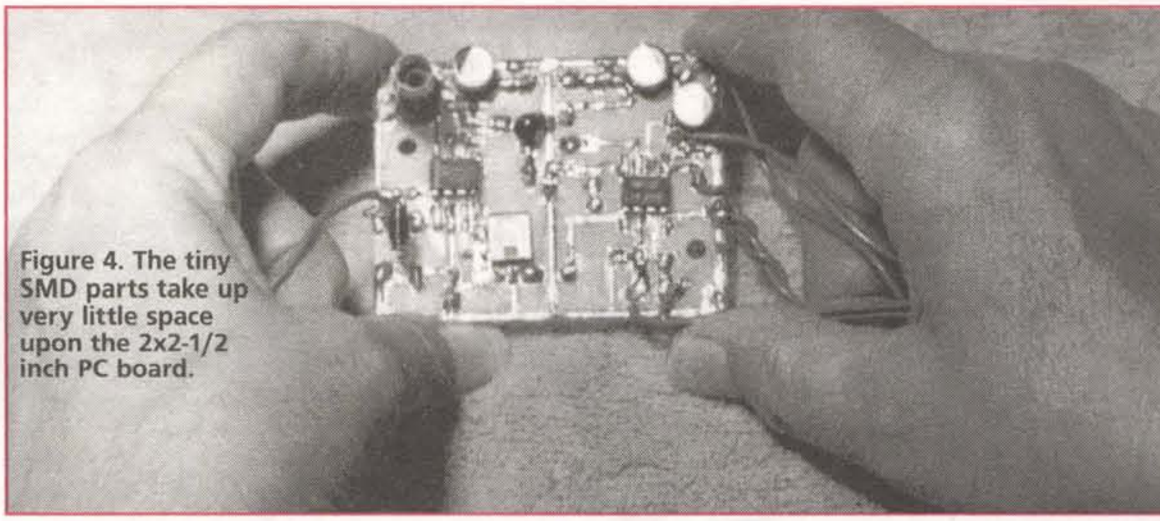


Figure 4. The tiny SMD parts take up very little space upon the 2x2-1/2 inch PC board.

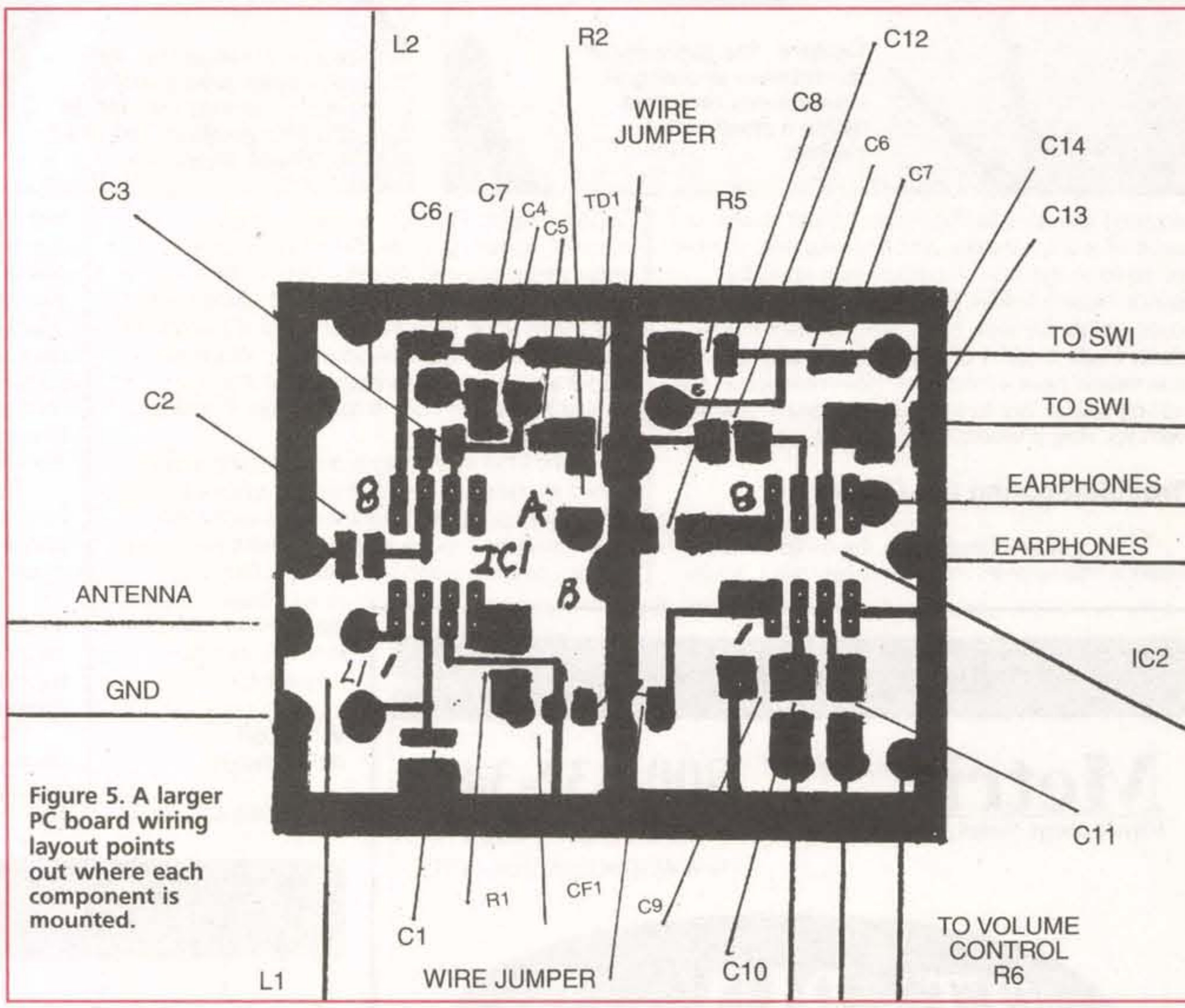


Figure 5. A larger PC board wiring layout points out where each component is mounted.

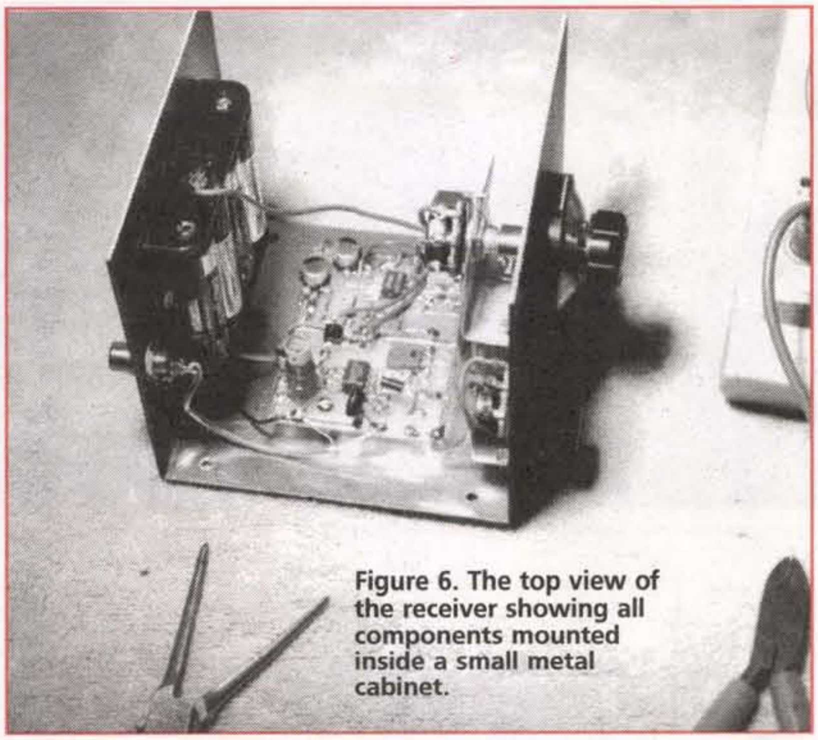


Figure 6. The top view of the receiver showing all components mounted inside a small metal cabinet.

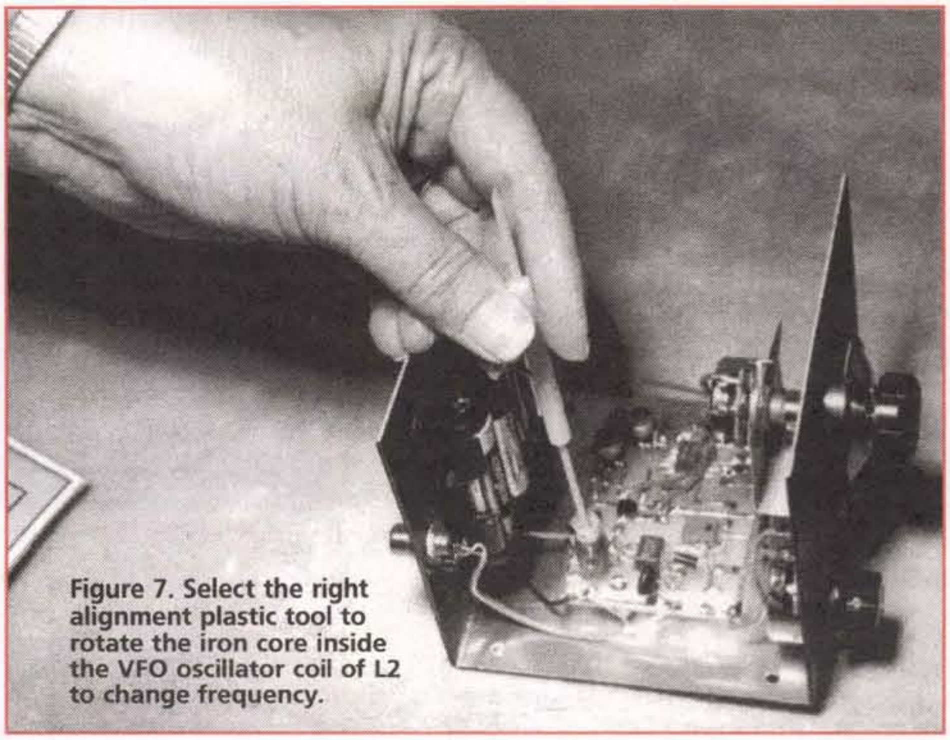


Figure 7. Select the right alignment plastic tool to rotate the iron core inside the VFO oscillator coil of L2 to change frequency.

antenna wire to C16. Tie in the 1.5-volt source to pin 6 of IC2 for testing. A connecting wire can be soldered to the 1.5-volt battery rivet upon the plastic battery holder. First, test out the audio circuits. Rotate R6 wide open. Place a small screwdriver blade to pin 1 of IC2 or the wire jumper. You should hear a loud hum. Now connect up the +6-volt source. Try to tune in a shortwave station with R3. Hey, it works!

Troubleshooting the Chassis

If no sound is heard from the audio circuits, insert a milliamperes meter between the 1.5-volts source and pin 6 of IC2. Suspect a leaky IC2, shorted PC wiring, or misplaced parts if the measurement is over 10 mills. Double-check all audio part connections. Take critical voltage measurements upon each terminal pin of IC2 and compare with those upon the schematic. When pins 2 and 3 are touched with the blade of IC2, you should hear a low hum. A louder hum should be heard on pin 1.

When the audio stages are operating and no tuned in stations, check the voltage upon each pin of IC1 with the DMM. Double-check each SMD part connection to the PC board. Check each pin of IC1 to common ground for leakage. Only pin 3 should show a shorted measurement. Make sure the antenna is connected.

VFO Coil Alignment

On the 40 to 41 meter band, adjust the iron core of L2 almost clear out of the coil winding (Figure 7). Tune in a strong shortwave station. Compare this frequency with those of another commercial built receiver, if one is available. You can now check the frequency of the station received. Also, check the frequency of the station as they provide it on the hour. Another method is to place the small shortwave receiver next to a commercial one and rotate the tuning dial until a beat whistle or squeal is heard.

Trace the oscillator whistle to the high and low end of the dial. The 41 meter frequency is in the 7 MHz band. You may be able to tune in the time signal station of Ottawa, Canada at 7.335 KHz.

To adjust the SMD receiver to the 30-31 meter band, set the tuning dial in the center of rotation. Adjust L2, until WWV at 10MHz (10,000KHz) is heard. This standard frequency and time station operates from Fort Collins, CO.

Now you can sit back and listen to the many shortwave stations and see what is going on all around the world, with this tiny SMD SW receiver. **NV**

Parts List

IC1	NE-602N IC	Oak Hills Research
IC2	Z416E IC	Kelvin Electronics
L1	8.2uH molded RF coil #9230-42	Circuit Specialists, Inc.
L2	4.60 to 8.50 uH adjustable coil #23686RPC	Circuit Specialists, Inc.
CF1	455KHz ceramic filter #TK2330-ND	Digi-Key, Inc.
C1	0.01uF 50V SMD capacitor	
C2,C3,C4	100 pF NPO 50V SMD capacitors	
C5	0.001uF NPO 50V SMD capacitor	
C6,C8,C9,C10, C11,C12,C14	0.1uF 50v SMD capacitors	
C7,C13,C15	100uF 16-volt SMD electrolytic capacitors	
C16	100 pF NPO or Silver Mica 50V capacitor	
R1	100 ohm 1/8-watt SMD resistor	
R2	10K ohm SMD resistor	
R3	10K ohm linear taper variable control	
R4	100K ohm SMD resistor	
R5	1000 ohm SMD resistor	
R6	10K ohm audio taper volume control	
SW1	DPST miniature toggle switch	
TD1	MV2109 33 or 36 pF tuning diode	
J1	Miniature antenna jack	
J2	Miniature stereo headphone jack	
1	Four AA 1.5-volt plastic battery holder	
1	Cabinet – LMB #444 metal; 4" depth x 4"wide x 2-5/8" height or equivalent	
Misc.	PC board, hook-up wire, batteries, solder, etc.	

Events CALENDAR

APRIL 2000

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

All listing information should be sent to:
Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

APRIL 1

CA - HANFORD - Swapmeet. Hanford Fraternal Hall, 10th Ave. @ Florinda. Talk-in: 145.11, 147.33, 224.44, 441.900 PL100. The Kings ARC, Rick 559-945-2266 8am-5pm. Doug 559-582-0949 8am-5pm

CO - LONGMONT - Hamfest. Boulder County Fairgrounds. VE Testing. Talk-in: 147.270+ repeater, 146.52 simplex. Longmont ARC, Fred Pilz KB0UUD, 303-678-5830. E-Mail: larc@qsl.net Web: http://www.qsl.net/larc/

CT - WATERFORD - Ham Radio Auction. Senior Center, Rt. 85. Talk-in: 146.730-. RASON, Tony Griggs AA1JN, 860-859-0162. Web: www.rason.org

MO - LEBANON - Hamfest. Lebanon ARC, Micki Jensen KC0EEX, 417-588-2335. E-Mail: mjensen@llion.org

NJ - WEST ORANGE - Hamfest. High School, 600 Pleasant Valley Way. 8:30am-1pm. IRAC, Jim Howe N2TDI, 973-402-6066

TX - BRENHAM - Hamfest. Brenham ARC, Dan Lakenmacher N5UNU, 409-836-8739. E-Mail: lindan@phoenix.net

APRIL 2

CT - SOUTHINGTON - Hamfest. High School. 9am-1pm. Southington ARC, Chet Bacon KA1ILH, 860-628-9346. E-Mail: chet@chetbacon.com Web: http://www.chetbacon.com/sara.html

NC - KINSTON - Hamfest. Lenoir County Fair Grounds. 8am-3pm. FCC Exams. Talk-in: 146.085/146.685. Down East Hamfest Assn., Doug Burt W4OFO, 252-524-5724

APRIL 7-8

WI - MILWAUKEE - Hamfest. Amateur Electronic Supply. Ray Grenier K9KHW, 414-358-4088. E-Mail: rayk9khw@aol.com Web: http://www.aes/jam.com

APRIL 8

AR - FORT SMITH - Hamfest. Columbus Hall, 10201 Columbus Acres Rd. VE Testing. Talk-in: 146.940. Fort Smith Area ARC, Kelsey Mikel KK5KU, 501-651-7003. E-Mail: kk5ku@amsat.org Web: http://www.qsl.net/fsaarc

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

MN - ROCHESTER - Hamfest. Graham Arena E., Olmsted County Fairgrounds. VEC Testing. Rochester ARC, John Scott N0HZN, 507-285-6522. E-Mail: n0hzn@aol.com Web: http://members.aol.com/rarchams

NH - TWIN MOUNTAIN - Hamfest. Town Hall. 8am-2pm. VE Exams. Talk-in: 147.345 (114.8 Hz). North County ARC and LARK, Richard Force WB1ASL, 603-788-4428. E-Mail: bhabooks@together.net Web: http://www.qsl.net/k1ncr

OK - LAWTON - Hamfest. Lawton Ft. Sill ARC, Bob Morford KA5YED, 580-353-8074 or 580-355-6120

TN - CLINTON - Hamfest. Old Armory. 9am-4pm. Talk-in: 146.880 or 146.970. Oak Ridge ARC, David Bower K4PZT, 865-690-8360. E-Mail: d.bower@ieee.org Web: http://www.kornet.org/orarc

WA - SPOKANE - Hamfest. Spokane Community College. 9am-5pm. VE Testing. Talk-in: 146.52 simplex and 147.38 repeater. Lilac City ARC, Warren Kelsey KJ7BB, 509-534-8443

APRIL 8-9

FL - SARASOTA - Sarasota Municipal Auditorium, 801 N. Tamiami Trl. Frank Cox Productions, 941-954-0202

APRIL 9

NC - RALEIGH - State Convention. Jim Graham Bldg., NCS Fairgrounds. 8am-4pm. Raleigh ARC, Chuck Littlewood K4HF, 919-992-5851. E-Mail: k4hf@arrl.net Web: http://www.rars.org

NJ - HAMILTON TWP. - Hamfest. Tall Cedars of Lebanon picnic grove, Sawmill Rd. Talk-in: 146.67-. 609-882-2240. Web: http://www.slac.com/w2zq

PA - MONROEVILLE - Hamfest. Palace Inn, Mosside Blvd. 8:30am-3pm. Talk-in: 146.73, 147.12 repeaters and 146.52. Two Rivers ARC, Michael Kowalcheck KV3L, 412-751-9657. E-Mail: w3oc@nb.net Web: http://www.qsl.net/w3oc

WI - STOUGHTON - Hamfest. Mandt Community Center, 400 Mandt Pkwy., Junior Fairgrounds. 8am-1pm. Talk-in: 147.75/.15. Madison Area Repeater Assn., Paul Toussaint N9VWH, 608-245-8890. E-Mail: n9vwh@arrl.net Web: http://www.qsl.net/mara/

APRIL 14-15

GA - ATLANTA - Southeastern VHF Conference. Marriott Hotel at Windy Hill in Marietta. Talk-in: 145.47(-). Southeastern VF Society, Dick Hanson K5AND, 770-844-7002. E-Mail: k5and@ga.prestigue.net Web: http://www.svhfs.org

APRIL 14-15-16

CA - VISALIA - International DX Convention. Holiday Inn. Southern CA DX Club, Cathy Gardenias KF6LFB, 909-862-0720. E-Mail: wu6d@dreamsoft.com Web: http://www.scdxc.org

APRIL 15

AL - ALBERTVILLE - Hamfest. Marshall County ARC, Buddy Smith KC4URL, 256-593-2516. E-Mail: kc4url@hiwaay.net

FL - MIAMI - Hamfest. Physics Parking Lot, University of Miami Campus. Talk-in: 146.865 (-6). Flamingo/University of Miami ARC, Walt W4DWN, 305-895-0398

MN - BLAINE - Midwinter Madness. National Sports Center, 1700 105th Ave., N.E. 7:30am-2:30pm. VE Testing. Robbinsdale ARC, Harriet Johanson KB0UPG, 612-537-1722. E-Mail: k0ltc@visi.com Web: http://www.visi.com/~k0ltc

NC - MORGANTON - Hamfest. Burke County Fairgrounds. 8am-4pm. Tom Taylor KC4QPR, 828-433-6205. E-Mail: kc4qpr@vistatech.net Web: http://www.wp.cc.nc.us/~cvhamfest/

NE - OMAHA - Hamfest. St. Joan of Arc Church Parking Lot, 74th & Hascall. 8am-10:30am. VE Testing. Talk-in: 146.94. Heartland DX Assn., Todd LeMense KK0DX, 402-397-7465. E-Mail: kk0dx@arrl.net Web: http://www.qsl.net/hdxa/tailgate

VA - CHESAPEAKE - Hamfest. Civitan Acres, 2210 Cedar Rd. 8am-12pm. Talk-in: 146.610 (-600). Chesapeake AR Service, Walton Hood K4WYS, 757-487-0357. E-Mail: wrhood@exis.net Web: http://www.qsl.net/cars

APRIL 16

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

MI - GROSSE POINTE - Hamfest. Grosse Pointe North High School, 707 Vernier Rd. 8am-2pm. Talk-in: 146.74-. South Eastern MI ARA, Jerry Rosner N8FGK, 313-331-3336. E-Mail: n8fgk@amsat.org Web: http://members.home.net/semara

MN - SHAKOPEE - Hamfest. Canterbury Park. 12-5pm. VE Testing. Talk-in: 147.165+. SMARTS, POB 144, Chaska, MN 55318

APRIL 21-22

AR - LITTLE ROCK - Little Rock Hamfest. The Little Rock Expo Center, Exit 126 on I-30. Fri: 4-9pm, Sat: 8am-4pm. Jim Blackmon K5VZ, 870-246-7833 (h) or 870-246-6734 (w). Fax: 870-246-6736. E-Mail: lrhamfest@usa.net Web: http://www.aristotle.net/~ares/hamfest/

APRIL 22

ID - IDAHO FALLS - Hamfest. Idaho Falls Elks Lodge, 640 East Elva. Talk-in: 443.00+, 147.15+. Eastern ID UHF Society, Jay Greenberg WA4VRV, 208-524-1388 or 208-526-7033. E-Mail: wa4vrv@srv.net Web: http://www.srv.net/~wa4vrv/hamfest.htm

KY - MURRAY - Hamfest. National Guard Armory. 8am-1pm. VE Testing. Murray State University ARC, Billy Miller KB9RPO, 270-762-6433 or 618-244-1179. E-Mail: billy.miller@murraystate.edu Web: http://www.mursuky.edu/clubs/msuarc/hamfest/ham-fest.htm

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

APRIL 29

AL - MOULTON - Hamfest. H. A. Alexander Park, Court Street. 9am-4pm. VEC Testing. Talk-in: 53.17, 146.96 and 442.425. Bankhead ARC, Rex Free KN4CI, 256-905-0822. Web: http://www.homestead.com/n4idx

CA - SONOMA - Hamfest. Sonoma Valley Veteran's Memorial Bldg., 126 1st St. W. 8am-12pm. VE Testing. Talk-in: 145.35, -600, PL 88.5. Valley of the Moon ARC, Darrel Jones WD6BOR, 707-996-4494

IA - DES MOINES - Hamfest. Des Moines RAA, Duane Bower WB0UCY, 515-287-6542. E-Mail: duaneab@uswest.net

IL - STICKNEY - Hamfest. Hawthorne Race Course, 3500 S. Cicero Ave. VE Testing. Talk-in: 145.25. DuPage ARC, 630-985-9256. E-Mail: DARCHamfest@aol.com Web: HTTP://WWW.W9DUP.ORG

SC - SPARTANBURG - Hamfest. County Fairgrounds, 275 W. Bishop St. 8am-3pm. Blue Ridge ARS, Inc., Robert G. Watson W4RGW, E-Mail: w4rgw@arrl.net

TX - BELTON - Hamfest. Bell County Expo Center. 7am-2pm. Talk-in: 146.820- MHz (PL 123.0). Temple ARC, Mike LeFan WA5EQQ, 254-773-3590. E-Mail: hamexpo@tarc.org Web: http://www.tarc.org

APRIL 30

DE - NEW CASTLE - State Convention. Nur Temple, Rt. 13. 8am-1pm. VE testing. Talk-in: 146.955- or 224.220/R. Penn-Del ARC, Hal Frantz KA3TWG, 302-793-1080. E-Mail: hfrantz@snip.net Web: http://www.magpage.com/penndel

IL - ARTHUR - Hamfest. Moultrie/Douglas County Fairgrounds. 8am-1pm. Talk-in: 146.055/146.655 & 449.275/444.275. Moultrie ARK, Ralph Zancha WC9V, 217-543-2178 days and 217-873-5287 eves. E-Mail: rzancha@one-eleven.net

IL - GALVA - Hamfest. Galva National Guard Armory. 8am-2pm. VE Testing. Area Amateur Radio Operators Club, Bill Anderson WA9BA, 309-932-3023. E-Mail: bill@inw.net Web: http://www.qsl.net/aaro/index.html

OH - ATHENS - Hamfest. Athens Recreation Center. 8am-2pm. Talk-in: 145.15(-). Athens County ARA, John Cornwell NC8V, 740-593-6474. E-Mail: jcornwell@eurekanet.com Web: http://www.seorf.ohiou.edu/~xx017/hamfest.html

PA - WASHINGTON - Hamfest. WACOM, Dave DeMotte N3IDH, 724-228-8178. E-Mail: n3idh@bellatlantic.net

MAY 2000

MAY 5-6

LA - BATON ROUGE - State Convention. Baker Civic Auditorium, 3325 Groom Rd. VE Testing. Baton Rouge ARC, Herb Ramey W5LSU, 225-654-6087. E-Mail: W5GIX@AOL.COM Web: http://www.brarc.org

MAY 6

AR - SILOAM SPRINGS - Hamfest. St. Mary's Catholic Church,1996 Hwy. 412 E. 8am-3pm. Talk-in: 146.67. Siloam Springs ARC, Matt Hyde N5UYK, 501-524-4797

AZ - SIERRA VISTA - Hamfest. Cochise ARA, Raymond Berger W1LYT, 520-378-4214

CO - MONUMENT - Hamfest. Lewis-Palmer High School, 1300 Higby Rd. 8am-2pm. Talk-in: 146.970 (100Hz) or 146.520 simplex. Pikes Peak RAA, Robert Ryals KI0GF, 719-265-9950.

COMPUTER SHOWS

AGI Shows, 317-299-8827. E-Mail: info@agishows.com http://www.agishows.com

Blue Star Productions 612-788-1901. http://www.supercomputersale.com

Computers And You, 734-283-1754. www.a1-supercomputersales.com

Computer Central Shows 847-412-1900 & 1-888-296-6066. E-Mail: compcent@megsinet.net www.computercentralshows.com

Computer Country Expo 847-662-0811 Web: www.ccxpo.com

Five Star Productions 810-379-3333. E-Mail: jeff@fivestar www.fivestarshows.com

Georgia Mountain Productions 706-838-4827. E-Mail: gamtnpro@blrg.tds.net georgiamountain.com

Gibraltar Trade Center, Inc. 734-287-2000. Taylor, MI. E-Mail: taylor@gibraltartrade.com www.gibraltartrade.com

Gibraltar Trade Center, Inc. 810-465-6440. Mt. Clemens, MI. E-Mail: mtclemens@gibraltartrade.com www.gibraltartrade.com

KGP Productions 1-800-631-0062, 732-297-2526. E-Mail: kgp@mail.com

MarketPro, Inc., 201-825-2229. http://www.marketpro.com

MarketPro, Inc., 301-984-0880. E-Mail: md@marketpro.com http://marketpro.com

Narisaam Computer Show 770-663-0983. E-Mail: narisaam@aol.com Web: http://www.shownsale.com

Northern Computer Shows 978-744-8440. E-Mail: inquiries@ncshows.com Web: ncshows.com

Peter Trapp Computer Shows 603-272-5008. Web: www.petertrapp.com

Events CALENDAR

E-Mail: rryals@pcisys.net
Web: http://www.qsl.net/ppraa/swapfest.htm
KY - LOUISA - Hamfest. Louisa Middle School. Talk-in: 147.390+ repeater. Big Sandy ARC, Fred Jones WA4SWF, 606-638-9049. E-Mail: wa4swf@arrl.net Web: http://qsl.net/wa4swf/
MI - CADILLAC - Hamfest. Wexaukee ARC, Alton McConnell NU8L, 231-862-3774.
E-Mail: amcconnell3@hotmail.com
WI - CEDARBURG - Hamfest. Ozaukee RC, Joe Holly AA9HR, 262-377-2137; E-Mail: aa9hr@execpc.com. Skip Douglas, 262-284-3271

MAY 6-7

AL - BIRMINGHAM - Hamfest. Glenn Glass KE4YZK, 205-681-5019.
E-Mail: ke4yzk@bellsouth.net Web: http://www.bro.net/barc/slideshow/index.html
NJ - EDISON - Trenton Computer Festival. NJ Convention & Exposition Center, Raritan Center. KGP Productions, Inc., 1-800-631-0062.
E-Mail: kgp@mail.com Web: http://pcshow.com
TX - ABILENE - Hamfest. Abilene Civic Center. Sat: 8am-5pm, Sun: 9am-2pm. VE Tesing. Talk-in: 146.160/760. The Key City ARC, Peg Richard KA4UPA, 915-672-8889. E-Mail: ka4upa@arrl.net

MAY 7

IL - SANDWICH - Hamfest. Sandwich Fairgrounds. 8am-2pm. Talk-in: 146.730- or 146.52 simplex. Kishwaukee ARC, Bob Yurs W9ICU, 815-895-3219.
E-Mail: w9icu@tbcnet.com Web: http://www.tbcnet.com/~jleonard/hamfest.htm
MD - HAGERSTOWN - Hamfest. Hagerstown Community College Recreation Center. VE Testing. Talk-in: 146.94 & 147.09. Antietam RA, Inc., Tina Jones KB8ZQM, 304-728-7769.
E-Mail: kb8zqm@intrepid.net
Web: http://www.qsl.net/w3cwc
NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053.
E-Mail: wb2slq@juno.com
Web: http://www.metro70cmnetwork.com
PA - WRIGHTSTOWN - Hamfest. Middletown Grange Fairgrounds. Talk-in: 147.09 and 443.950. Warminster ARC, Roy Conners K3TEN, 215-974-9373. E-Mail: k3ten@arrl.net
Web: http://www.voicenet.com/~k3dn

MAY 12-13

NH - ROCHESTER - Hamfest. Fairgrounds. Hoss Traders, Joe, 207-469-3492

MAY 13

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

MAY 13-14

CA - FERNDALE - Hamfest. Humboldt ARC, Marcy Campbell KE6IAU, 707-442-3866.
E-Mail: marcidon@quik.com
Web: http://www.humboldt.com
WA - YAKIMA - State Convention. Masonic Center, 510 N. Naches Ave. Sat: 9am-4pm, Sun: 9am-1pm. VE Testing. Yakima ARC, Jack Wrenn N7KNO, 509-249-0897. E-Mail: n7kno@arrl.net
Web: http://eagle.ykm.com/~w7aq/hamfest.html

MAY 19-20-21

OH - DAYTON - ARRL National Convention. Dayton ARA, Dave Coons WT8W, 937-849-0604.
E-Mail: wt8w@arrl.org
Web: http://www.hamvention.org

MAY 20-21

IL - ELGIN - CoCoFEST. Elgin Plaza Hotel, 345 W. River Rd. Tony Podraza 847-428-3576.
E-Mail: tonypodraza@juno.com

MAY 21

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

MAY 26-27

MS - PASCAGOULA - Hamfest. Civic Center, Jackson County Fairgrounds. Fri: 5-9pm, Sat: 8am-2pm. VE testing. Talk-in: W5WA 145.110-. Jackson County ARC, Charles F. Kimmerly N5XGI, 228-826-5811.
E-Mail: montehat@datasync.com

MAY 27

KY - DAWSON SPRINGS - Pennyrile Area Tailgatefest 2000. Dawson Springs ARC, Princeton ARS, Hopkins County ARA, & Pennyroyal ARS, Curt Beshear KE4UZE, 270-797-9117. E-Mail: ke4uze@spis.net
NC - DURHAM - Hamfest. South Square Mall. 8am-3pm. FCC Exams. Talk-in: 147.225+. Durham FM Assn., Joseph Fields KF4QYY, 919-596-3738. Web: http://www.vramp.net/~dfma/

MAY 27-28

WY - CASPER - State Convention. Radisson Inn. Casper ARC, Warren (Rev) Morton WS7W, 307-235-2799 or 307-237-9301. E-Mail: mortonwg@aol.com
Web: http://w3.trib.com/~carc/hamfest.html

MAY 28

MD - WEST FRIENDSHIP - Hamfest. Howard County Fairgrounds. 8am-2:30pm. Talk-in: 146.76, 224.76, 444.00. Maryland FM Assn., Mike WA3TID, 410-923-3829

JUNE 2000

JUNE 2-3-4

NY - ROCHESTER - Convention. Monroe County Fairgrounds, Rt. 15A. Fri: 12pm-5:30pm, Sat: 8:30am-5:30pm, Sun: 8:30am-1:30pm. Harold Smith K2HC, 716-424-7184.
E-Mail: rochfst@frontiernet.net
Web: http://www.rochesterhamfest.org

JUNE 3

IL - SPRINGFIELD - Hamfest. State Fairgrounds, Gate 11. VE Testing. Talk-in: 146.685-. Sangamon Valley RC, Edmund Gaffney KA9ETP, 217-628-3697. E-Mail: egaffney@family-net.net
Web: http://www.w9dua.net
ME - HERMON - Hamfest. Pine State ARC, Edward Richardson K1DTW, 207-825-4417.
E-Mail: edandglo@earthlink.net
MI - GRAND RAPIDS - Hamfest. Hudsonville Fairgrounds. VE Testing. Talk-in: 147.16. Independent Repeater Assn., Kathy KB8KZH, 616-698-6627 between 4-7pm Eastern.
Web: http://www.iserv.net/~w8hvg
NJ - TEANECK - Hamfest. Fairleigh Dickinson University. 8am-2pm. Talk-in: 146.19/79. Bergen ARA, James Joyce K2ZO, 201-664-6725. E-Mail: hamfest@bara.org Web: http://www/bara.org

JUNE 3-4

OR - SEASIDE - Northwestern Division ARRL Convention. Convention Center. VE testing. Talk-in: 146.660 (-600). SEAPAC, Randy Stimson KZ7T, 503-297-1175. Web: www.seapac.org

JUNE 4

Events CALENDAR

IL - PRINCETON - Hamfest. Bureau County Fairgrounds. Talk-in: 146.955 -600 PL 103.5. Starved Rock Radio Club, Alan Erbrederis N9PIB, 815-498-9675. E-Mail: erb.n9pib@junol.com Web: http://www.qsl.net/w9mks/hamfest/htm

PA - BUTLER - Hamfest. Butler Farm Show Grounds. 8am-4pm. Talk-in: 147.96/36. Breezeshooters ARC, H. Rey Whanger W3BIS, 412-826-8006. E-Mail: w3bis@breezeshooters.net Web: http://www.breezeshooters.net

VA - MANASSAS - Hamfest. Prince William County Fairgrounds. Talk-in: 146.97-, 224.660-, 442.200+. Ole Virginia Hams ARC, Jack McDermott N4YIC, 703-335-9139. E-Mail: N4YIC@arrl.net or patnjack@erols.com Web: http://www.qsl.net/olevahams/

JUNE 9-10

TX - ARLINGTON - State Convention. HAM-COM, Maury Guzick W5BGP, 214-804-0680. E-Mail: chairman@hamcom.org Web: http://www.hamcom.org

JUNE 10

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

MO - MACON - Hamfest. Macon Vo-Tech School. 8am-12pm. FCC Exams. Talk-in: 146.805(-). Macon County ARC, Dale Bagley K0KY, 660-385-3629. E-Mail: n0pr@arrl.net Web: http://www.cyberusa.com/~kfoster/hamfest.htm

NC - WINSTON-SALEM - Hamfest. Forsyth ARC, John Kippe N0KTY, 336-723-7388. Web: http://members.xoom.com/w4nc/hamfest.htm

PA - BLOOMSBURG - Eastern PA Section Convention. Bloomsburg Fairgrounds. 8am-3pm. VEC Testing. Talk-in: 147.225 (+600) and 146.52 simplex. Columbia-Montour ARC, George Law N3KYZ, 570-784-2299. E-Mail: n3kyz@epix.net Web: http://www.bafn.org/~cmarc

JUNE 11

IL - WHEATON - Hamfest. Six Meter Club of Chicago, Joseph Gutwein WA9RIJ, 630-963-4922 or 708-442-4961. E-Mail: wa9rij@mc.net Web: http://cyberconnect.com/orion/smcc.html

NY - BETHPAGE - Hamfest. Long Island Mobile ARC, Ed Muro KC2AYC, 516-520-9311. E-Mail: hamfest@limarc.org Web: http://www.limarc.org

OH - CANFIELD - Hamfest. Twenty Over Nine ARC, Don Stoddard N8LNE. E-Mail: n8lne@juno.com

OH - SUFFIELD - Hamfest. Goodyear ARC, Fred Mealy KC8BQX, 330-665-4563. E-Mail: fmealy@earthlink.net

TN - KNOXVILLE - Convention. National Guard Armory, 3330 Sutherland Ave. 9am-4pm. VE Exams. Talk-in: 147.30+, 224.50-, 444.575-. RAC of Knoxville, David Bower K4PZT, 423-670-1503. E-Mail: rack@kormet.org Web: http://www.kormet.org/rack

JUNE 17

MO - HOUSTON - Hamfest. Ozark Mountain Repeater Group, Blanche White N0FLR, 417-967-3000

NJ - DUNELLEN - Hamfest. Raritan Valley Radio Association, Fred Werner KB2HZO, 732-968-7789. E-Mail: wb2njh@aol.com Web: http://www.w2qw.org

JUNE 18

IN - CROWN POINT - Hamfest. Lake County ARC, Rick Terpstra WN9Z, 219-696-8324. E-Mail: terpstra@netnitco.net

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

MI - MONROE - Hamfest. Monroe County Radio Communications Assn., Fred VanDaele KA8EBI, 734-587-2250 or 734-242-9487. E-Mail: ka8ebi@arrl.net Web: http://www.mcrca.org

OH - MACEDONIA - Hamfest. Nordonia High School. 8am-1pm. Talk-in: 146.82(-) repeater. Cuyahoga ARS, Rich James N8FIL, 1-800-404-2282. E-Mail: n8fil@aol.com Web: http://www.cars.org

JUNE 24-25

CA - FERNDALE - Hamfest. Humboldt ARC, Marcy Campbell KE6IAU, 707-442-3866. E-Mail: marcidon@quik.com Web: http://www.humboldt.com

JULY 2000

JULY 2

PA - WILKES-BARRE - Hamfest. Murgas ARC, Stanley Perry KE3TC, 570-735-2385. E-Mail: slperry@epix.net

JULY 7-8-9

UT - BRYCE CANYON - State Convention. UT Hamfest Committee, Kathy Rudnicki N7JSH, 801-547-9218. Web: http://www.utahhamfest.org

JULY 8

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

GA - GAINESVILLE - State Convention. Georgia Mountains Center. 8:30am-3pm. VE Testing. Talk-in: 146.67(-). Lanierland ARC, Ken Johnson NZ4Q, 706-335-9658. E-Mail: nz4q@aol.com Web: http://www.mindspring.com/~w4tl/hamfest.htm

IN - INDIANAPOLIS - Central Division Convention. Indianapolis Hamfest Assn., Rick Ogan N9LRR, 317-257-4050. E-Mail: oganr@in.net Web: http://www.indyhamfest.com

MO - KANSAS CITY - Hamfest. PHD ARA, Bob Roske WA0CLR, 816-436-0069. E-Mail: wa0clr@worldnet.att.net Web: http://members.tripod.com/~PHDARA/

NC - SALISBURY - Hamfest. Salisbury Civic Center. VE Testing. Talk-in: 146.73 tone 94.8 and 146.52 simplex. Rowan ARS, Jim Morris KA4MPP, 704-278-4960 or Carol Maher W4CLM, 704-633-6603. E-Mail: rbrown@salisbury.net

WI - OAK CREEK - Hamfest. The American Legion Post 434, 9327 S. Shepard Ave. 6:30am-4pm. Talk-in: 146.52 simplex. South Milwaukee ARC, Bob Kastelic WB9TIK, 414-762-3235 days & early eves.

JULY 9

IL - PEOTONE - Hamfest. Will County Fairgrounds. Talk-in: 146.94 (-600). Kankakee Area Radio Society, Don Kerouac K9NR, 815-939-7548. E-Mail: k9nr@juno.com Web: http://www.w9az.com

PA - PITTSBURGH - Hamfest. North Hills ARC, Keith Ostrom KB3ANK, 412-821-4135. Web: http://www.nharc.pgh.pa.us

JULY 14-15-16

MT - EAST GLACIER - State Convention. Glacier/Waterton Int'l Hamfest Committee, Frank Phillips AC7AY, 406-273-2894. E-Mail: ac7ay@bigsky.net Web: http://www.tlatech.com/hamfest/

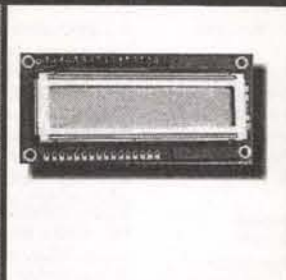
Continued on page 83

Write in 52 on Reader Service Card.

LOWEST COST LCD'S ON EARTH

VIDEO LCD

4 Inch Video NTSC $150
Sharp P/N 4LU4E
Composite NTSC & RGB Input
12:00 OR 6:00 Viewing Angle
Integrated Backlight & Inverter
Extended Temp: -10 to + 60 C
Brightness: 260 nits
Power Consumption: 4.3 Watts
Contrast: 50 to 1



CHARACTER LCD

OPTREX DMF-5005SN-EW
240 x 64 Graphic EL Backlit STN $30
OPTREX DMF-5005N
240 x 64 Graphic Reflective STN $30
SANYO DM2023-7G1
2 x 20 Character Reflective STN $8
SHARP LM20A21
2 x 20 Character Reflective STN $8
VIKAY 2035TNLD NOTW-D
2 X 16 Character LED Backlit STN $8

LCD MONITOR

10.4" DSTN or 12.1" TFT
Analog SVGA Input
Autosync
Auto Sizeing
Automatic Expansion of VGA images to SVGA (On 12.1")
Very Aggressive Pricing Starting under $500!

TOUCH MONITOR

EarthVue 10.4
10.4" VGA TFT
Analog VGA Input
105 Nit Brightness
RS-232 Touch Screen Option
Only 9.9"W x 7.7"H x 1.5"D
Ideal For Factory Automation
Fully Articulating Ball Mount
Only $1095 With Touch

LCD DISPLAYS

6.3" Mono STN	$60
9.4" Mono Reflective	$60
8.4" TFT	$250
9.4" DSTN	$150
10.4" TFT	$350
10.4" DSTN	$240

NoteBook Screens
340 Models in Stock
Obsolete Screens Stocked
Hard To Find LCD? Call!

CONTROLLERS

ISA
PCI
PC/104
NTSC
Analog VGA
Complete LCD Kits with LCD, Controller & Cable Starting under $200

EARTH Computer Technologies
"The World Leader In LCD Recycling"

Ph: (949) 361-2333 Fax: (949) 361-2121
http://www.flat-panel.com

Write in 29 on Reader Service Card

C and H SALES COMPANY

2176 E. Colorado Blvd. • Pasadena, CA 91107

TOLL FREE: 1-800-325-9465

FREE 148 PAGE CATALOG!

C & H SALES COMPANY HAS BEEN IN BUSINESS FOR OVER FIFTY YEARS.
WE'RE THE BEST SOURCE FOR GREAT BUYS ON ITEMS LIKE THESE - AND MORE!

ELECTRONIC COUNTER
HEWLETT PACKARD, Model 5328A. Universal counter. Usable to 100 MHz, 100 ns single shot resolution. Has frequency, period, period average, ratio, totalize, scale functions. A built-in digital voltmeter allows measurements of input voltages. Two input channels provide individual slope, polarity and level settings. Has 9 digit LED readout. Input power 100–240 VAC 48–66 Hz 100 VA max. Dimensions: 17" wide x 17-1/4" deep x 3-1/2" high.
Stock #TE9808 $250.00

MILLIOHMETER
HEWLETT PACKARD, Model 4328A. Designed to measure very low resistances. Measurement range 1m ohm to 100 ohms. Resolution 20 u ohms. Analog meter readout. Ideal for measuring contact resistance of switches or relays. This unit is also useful for measuring the resistivity of semiconductor devices. (Requires special 4 terminal probes which are not supplied, but probably are available from Hewlett Packard.) Power input: 115–230 VAC 48–66 Hz, 5 VA max. Dimensions: 5-1/8" wide x 11-1/2" deep x 6-1/2" high.
Stock #TE9812 $200.00

SOLA CONSTANT VOLTAGE TRANSFORMER
SOLA ELECTRIC, #93-13-150. Harmonically neutralized constant voltage transformer. Rated at 500 watts. Input voltage 95 to 130 VAC 60 Hz. Output voltage 120 VAC. This unit is designed for rack or bench mounting. The meters on the front panel indicate output current and input/output voltage. A toggle switch is provided for selection of input or output voltage. The input voltage is connected at the rear of the unit via a covered electrical panel. Two standard 3-wire grounded electrical outputs are supplied on the front and rear panels. Dimensions: 19" wide x 14-1/4" high x 10-1/4" deep. Weight 59 lbs.
Stock #STR9900 $225.00

ALTIMETER/BAROMETER
KOLLSMAN, #MC-2 MS28074-2. Scale type altimeter with barometric setting scale window. Altimeter scale range –1000 to 80,000 feet. Barometric range 28.1 to 31.0 inch of mercury. An adjustment knob is provided for scale setting to local altitude or barometric pressure. Has white numerals on a black background. Illumination is provided. Electrical input is rated 115 VAC 400 cycles. Pressure input port is female 7/16"X20 thread. Standard aircraft panel 3-1/8" mount. Dimensions: 2-17/64" sq. x 7-1/2" deep.
Stock #STOCK #IN9900 $79.50

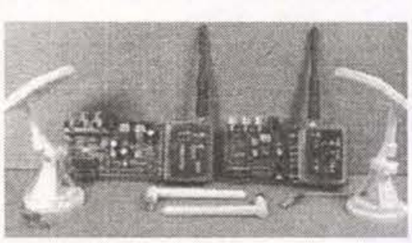
☑ Master Charge ☑ Visa ☑ American Express ☑ Discover

Call us first if you have surplus inventories of electronic, optical, or mechanical items for disposal

WE BUY & SELL!

Write in 30 on Reader Service Card

HAM GEAR FOR SALE



ATV-2400 and ATV-1200 2.4/1.2 GHz; 35/75 mW, 8 channels for legal ham use. **$159 per pair**, 1,000 watts maximum allowed by FCC. Power amplifiers, compact size, 1 watt output with SMAs, **$149**. Contact dealers through **EzATV www.4atv.com**

PRACTICAL ANTENNA HANDBOOK, by Joseph Carr. The most popular book on antennas ever written, widely known as "the antenna builder's bible." This *Third Edition* is a work for anyone with an interest in antennas, from the newest of novices to the most experienced engineer. This empowering book gives you all kinds of projects and material that explains why what you did works. Only $49.95! **10% discount to *Nuts & Volts* subscribers.** Call **1-800-783-4624** to order using Visa or MasterCard.

THE SMART BATTERY CHARGER for lead acid or gel cell batteries. Can be left connected to the battery **INDEFINITELY**, will not overcharge! Standard kit is 12V @ 1 amp. This kit is 100% complete. For the kit order #150-KIT at $59.95. For an assembled and tested unit, order #150-ASY at $79.95. CA residents add 7.75% sales tax. Add $6.50 per unit shipping. MC/VISA accepted. A&A Engineering, 2521 W. La Palma #K, Anaheim, CA 92801. 714-952-2114, FAX 714-952-3280.

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

SECRETS OF RF CIRCUIT DESIGN From Joseph Carr, one of today's most respected electronics authors, comes this pragmatic, intermediate-level guide to designing, building, and testing all types of radio frequency circuits. Filled with functional projects that demonstrate the principles of RF circuits. Only $29.95! **10% discount to *Nuts & Volts* subscribers.** Call **1-800-783-4624** to order using Visa or MasterCard.

HAM GEAR WANTED

CB — SCANNERS

240+ CHANNEL CB/HAM/COMMERCIAL radios: AM/FM/SSB/CW export/domestic: RCI, Motorola, Uniden, Cobra, Alinco, Kenwood. Mics, antennas, linears, meters, books, night scopes, and tons more stuff! Catalog $3. MAXTECH, Box 8086, New York, NY 10150. 718-547-8244.

CB MODIFICATIONS, repairs, new products, CB radios, exports, scanners, power supplies, microphones, amps, antennas, more! 15 yrs. same location, 6 page picture price sheets $1 (refundable). Galaxy, Box 1202, Akron, OH 44309. http://members.aol.com/galaxyelc

CB MODIFICATIONS! Frequencies, books, kits, high-performance accessories, plans, repairs, amplifiers, 10-meter conversions. The best since 1976! Catalog $3. CBCI, Box 1898NV, Monterey, CA 93942. www.cbcintl.com

SALES & SERVICE: CB equipment, modification kits, meters, antennas, mics, radios, transistors, repairs & hard-to-find items. Complete list $4. D&R Electronics, 10 Park St., Thomaston, CT 06787. 860-283-9492 or RTed821836@aol.com

HALCON COMMUNICATIONS Wholesale only: Cobra, Uniden, Midland, Galaxy, CTE, Super Star, Kenwood, Yaesu, Icom. Free catalog, Free call 1-800-683-6999.

MUSIC & ACCESSORIES

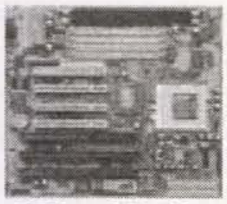
WANTED: 33 RPM center post for dual 1019 turntable. 704-545-9115 W4CUG.

COMPUTER HARDWARE

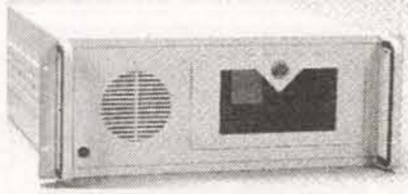
ISO7816 PROGRAMMER built $150. Kit $125. No software. Blank smart cards $20.00 or 8/$100. Tony 419-385-3100.

WE CARRY a variety of cables, switch boxes, accessories, and adapters to connect PCs, printers, Mac's, networks, telecommunications, and audio/video equipment. We offer: custom cables, free catalogs, and same day shipping on most orders. Visit our website at www.rogerssystems.com or call 1-800-366-0579.

Write in 45 on Reader Service Card.



333MHz CPU and Pentium motherboard super combo deal including AGP 3D 4MB video, sound. All I/O ports, 56K modem, LAN, ATX or normal power connectors, baby AT motherboard fits almost all cases, CD-ROM disc w/drivers, Corel 8 Suite & many FREE applications, 2 year motherboard warranty, only $139. Same as above but with PII 433MHz Celeron CPU and 8 megabyte video $189. Windows 95B $39. Order now 847-657-1160 or www.saveware.com VISA/MasterCard/AMEX/money order.



19" RACKMOUNT ATX PC chassis, $169 (with ad). 972-242-8087, www.cti-tx.com

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

EVERYTHING NEW w/warranty! Motherboards with CPU 500MHz $195, monitors 15" $125, Pentium systems from $195. Modems, multimedia kits, scanners, 2.5 gigabytes hard drives $65. 850 megabytes $27, 1.28 gigabytes $40. Call 714-778-0450. E-Mail: cci@surfside.net

CRTs CHEAP. Buy direct from the manufacturer. Save money. Mfg. all CRT types since 1950. **3 year warranty**. Reg-Res 19" tubes $75; 25" $100; hi-res 13" tubes from $80. We specialize in **hi-resolution** video/computer CRTs. **T.M.C.** 215-226-0749/215-223-0388.

PC CABLES: http://www.cablesusa.com 100s of hard-to-find new cables and parts, pictures, free technical information. Low prices, RS232, SCSI, keyboard, network, VGA, Cat-5, USB, Firewire, fast secure online ordering & browsing. 954-418-0817.

466MHz BAREBONE systems from $199. 486 computers $99. Brand name Pentiums from $199. Motherboards $20, Color printers $75, 1.44/1.2 floppies, speakers $10. 714-778-0450.

HARD DRIVES: 2.1GB IDE $59, 19.2GB IDE $125, 9.1GB SCSI $135. Order online at www.driveguys.com 1-888-773-3423, 818-773-9744.

COMPUTER SOFTWARE

FREE IBM DISK CATALOG of quality Shareware and CD-ROMs. **MOM 'N' POP'S SOFTWARE** <ASP>, PO Box 15003-N, Springhill, FL 34609-0111. 352-688-9108. momnpop@webcombo.net

SONY PLAYSTATION GAME ENHANCER, mod-chip function plays backup COPY of CD. You do not need to have original loaded to play backup. Simply plug the enhancer in back of playstation! Skips both Sony logos, many preloaded cheat codes. More $29. MOD-CHIP plays backups, works with all models and games $19, 120 save game memory card $19. Quantity prices available. Order now 847-657-1160 or on-line www.saveware.com VISA/MasterCard/AMEX/money order.

WINDOWS 95B only $39! (Super Price!) Windows 95B 4 CD pack, Encarta Encyclopedia, POD Racer, Hunter/Hunted $49, Windows 98SE (second edition) only $119! Includes 2 CDs w/Windows Tutorial, manual, boot floppy, and certificate, Norton utilities 3.0 WIN95/98 $19. Order now 847-657-1160 or on-line www.saveware.com VISA/MasterCard/AMEX/money order.

LOOKING FOR cheap clone PC parts that actually work? Call UTWE for CD-ROMs, hard drives, disk controllers, video cards, mainboards CPUs, etc. NEW clone-o-matic mainboard with 4 PCI, 4 ISA, 256K cache, I/O built on board with 200MHz AMD, CPU $70. 486 "all-in-one" mainboard with built on (video and IDE IO), $30 ea. with 66MHz CPU (fits generic case). Don't forget to check our auctions on Ebay! Seller name JohnUTWE. Remember, today we have it, tomorrow we don't! So E-Mail or call now. Case of 7 nearly new Epson keyboards, $21 ($3 ea.). There are other deals too! For the latest dealsheets send an E-Mail to dealsheets@utwe.com or call 626-930-1121 (10am-5pm Pacific) or fax 626-930-1123. E-Mail: sales@utwe.com

LOW-COST 12-BIT A/D KITS. $59 LPT: Analog! PC printer-port interface acquires 8 analog signals. Also features two 12-bit D/As, current sources for sensor excitation and digital I/O lines. QuickBasic and VB software included. 1-channel A/D only $39. http://www.tgn.net/~adnav/ or E-Mail: adnav@tgn.net

REFILL INKS FOR INKJET PRINTERS

Refill your old cartridge and save. All refill kits come with instructions and needed materials for refilling inkjet cartridges. Success guaranteed. Available for the following:

CANON BC-01, BC-02 CANON BJ10e, APPLE STYLEWRITER, BJ-200 Single, Black, $8.00. **CANON BJC-600** (BC-201) Single Black or Single Colors (3 refills) $8.00. **CANON BJ-130/300/330 & IBM Exec Jet** (Cart #BJI-481 & BJI-642) Black - 3-bottle kit $22.00. **CANON BJC-210/240** (BC-05 Cart) 3-color kit (3 refills each color for BC-05) $24.00. **CANON BJC-4000** and Apple Stylewriter 2400 Black 3-bottle kit (3 refills BC-20, 9 refills BCI-21 black, 30 refills BCI-11 black, 10 refills BCI-10) $19.00. **CANON BJC-4000/BJC70** and **Apple Stylewriter 2400** Tri-color kit - 6 refills each color for BCI-21 or 15 refills each color for BCI-11 $24.00. **CANON BJC-800/820/880** 3-bottle kit (for BJI-643B) $19.00. **CANON BJC-800/820/880** 3-bottle tri-color kit (Cart #BJI-643CMY) $24.00. **EPSON STYLUS COLOR PRINTER** - (Cart S020034) Single Triple black $19.00; Tri-color kit (Cart S020036) 2 refills each color $24.00. **EPSON STYLUS COLOR II** - (S020047) Triple Black $19.00 (S020049). Tri-color (2 refills each color) $24.00. **EPSON STYLUS COLOR 400, 500, & 600** (S020093) Triple black (7 refills total) $19.00. **EPSON STYLUS COLOR 200, 500** (S020097) Tri-color 3 refills each color $24.00. **EPSON STYLUS COLOR 400, 600, 800, 1520** Tri-color (S020089) 3 refills each color $24.00. **EPSON STYLUS 800/1000** (S020025) 3-refill kit, black, $19.00. **EPSON STYLUS COLOR 440 AND 640** Black refill kit. (S020187) 4 refills plus free vacuum bottle $19.00. **EPSON STYLUS COLOR 440, 640, AND 740** (S020191) Color refill kit. 4 refills of each color $24.00. **HP DESKJET 500/550/560** (51608A, 51633A, 51626A) Black single refills $8.00. **HP DESKJET 500/550/560.** Black 3-bottle kit $19.00. **HP DESKJET 500C/550C/560C .** Tri-color kit (5 refills each color) $24.00. **HP DESKJET 1200C, DESIGNJET 650** (Cart #HP 51640B) Black Three pack (3 refills) $19.00. **HP DESKJET 1200C/1600C, DESIGNJET 650** (Cart #HP 51640 C,M,Y). Tri-color kit (one refill each color) $24.00. **HP DESKJET 600/660** (HP 51629A) Black three pack $19.00. **HP DESKJET 600C/660C.** (HP 51649A) Tri-color (5 refills each color) $24.00. **HP DESKJET 855C/1600C** (HP 51645A) Black three pack $19.00. **HP DESKJET 855C** (HP 51641A) Tri-color kit (2 refills each color) $24.00. **HP PAINTJET** and **PAINTJET XL** (51606A) Black 3-bottle kit $19.00. **HP PAINTJET** and **PAINTJET XL** (51606C) Tri-color kit $24.00. **HP PAINTJET XL300** (C1645A & C1656A) Black 3-refill kit $19.00. **HP PAINTJET XL300** Tri-color kit (1 refill each color) HP 51639C,M,Y $24.00. **HP THINKJET, QUIETJET, KODAK DICONIX 150** (51604A or 92261A) black 5 refills $9.00. **IBM/Lexmark/Execjet/4076** (1380620) black 3-refill kit $19.00. **IBM/Lexmark ExecJet IIC, WinWriter 150 C** (Cart #1380619) 4 refills each color $24.00. **Lexmark 3200, 5000, 5700, 7000, 7200, Optra 45 and Z51** (12A1970) 3 refills Black $19.00. **Lexmark 3200, 6000, 5700, 7000, Optra 45 and Z51** (12A1980) 4 refills each color $24.00. **SNAP AND FILL SYSTEM** - Permits refilling HP 51626A (black for HP 500-series) and HP 51629A (black for HP 600-series) cartridges without making a hole in the cartridge. Consists of special cartridge holder, syringe, plastic tubing, and directions. **STARTER KIT** - with ink for 3 refills $28.00. **EXTRA INK FOR SNAP & FILL SYSTEM** (black only) 4-oz. bottle $18.00; 8-oz. bottle $34.00. Specify whether for HP 51626A or HP 51629A.

HARD-TO-GET PRINTER RIBBONS

Gorilla Banana, Commodore 1525 **$8.00**; Adam Coleco **$12.00**; TI-850/855 **$6.00**; Centronics 700 Zip Pack **$5.00**; C. Itoh Prowriter Jr., Riteman C+/F+ **$6.00**; Riteman Inforunner **$8.00**; Commodore MPS-801 **$5.00**; MPS 803 **$5.00**; Decwriter LA30/36 **$4.00**; Apple Scribe **$4.00**; Mannisman Tally Spirit 80, Commodore 1526 **$5.00**; Epson JX-80 4-Color **$14.00**. Printronix P-1013 **$11.00**; Star SJ144 color 3-pack **$29.00**.
ALSO HEAT & TRANSFER RIBBONS AND PAPER FOR PRINTING T-SHIRTS.

Over 300 different ribbons in stock. All ribbons new, not re-inked. Fully guaranteed. Order directly or send SASE for complete list.

Add $4 per order shipping. CA residents add 7.75% sales tax. On ribbon orders over $50 deduct 10% dis-

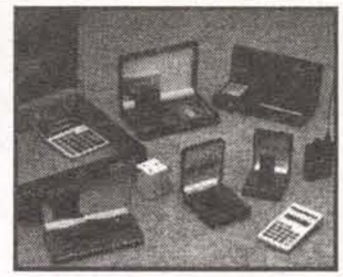
H.T. ORR Computer Supplies

249 Juanita Way, Placentia, CA 92870-2216

714-528-9822 · 800-377-2023 · FAX 714-993-6216

http://www.extremeplay.com/occomp/orr.htm

Write in 31 on Reader Service Card.



SURVEILLANCE

Room Transmitters. . . . . from **$30.00**
Telephone Transmitters . from **$29.00**
UHF Pen Transmitters **$299.00**
Crystal-Controlled
Transmitters . . . . from **$75.00**
UHF Telephone Transmitter
& Receiver & Recorder **$299.00**

Catalogues **$5.00**

And much more – too much to list here!

E-Mail: BitzTechnology@Compuserve.com

FMSTUDY32 FM, LPFM allocation studies. Manage FCC database on your PC! Manual included, $39.95. Demo, info, special Web pricing at http://members.xoom.com/fmstudy

CAM & MOTION SW/HW: Z-trace, PCB toolpath. Plotcam motion control, step drivers. **www.megabits.net/ddt** FAX 321-452-7197, 321-459-2729. **heater@megabits.net**

LIQUIDATION WINDOWS 95/98, Office suites $10-69. 1,000 games $25. Windows Tutorials $5, mastering Windows 98 book $10. 714-778-0450.

TIME SAVING utilities! Creative **Win98** software. Visit: **http://www.rascom1.com** today for **free** downloads. Questions? E-Mail: **rascom@mediaone.net**

UNDERGROUND CDs: Hacking, phreaking, free energy, health, anti-gravity, time travel, way-cool electronics projects, music & books. http://www.hi-techstuff.com

***Save 10%** on selected electronics books*, as a Nuts & Volts subscriber. See our ad on page 4.

COMPUTER EQUIPMENT WANTED

WANTED: FOR historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-763-3311/540-382-2935).

HP CALCULATORS wanted: models 10, 70, calculator watch, others for private collection. Cash paid. Bob Morrow, 765-855-2348, rkmorrow@aol.com

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

WANTED: HEATHKIT resistor substitution box. Will pay. Hugh M. Adams **hugh@emcst.com** or 850-864-2414. 1011D Hondo Ave., Ft. Walton Beach, FL 32547-3823.

8051 and AVR Programmer

Program 8051 and AVR microcontrollers for only $99!

PG302 - $75 ADT87 - $24 ADT90 - $24

- Includes Power Supply and Serial Cable
- Connects to PC Serial Port 1, 2, 3, or 4
- No Internal PC Card (Portable)
- High Quality ZIF Socket
- Includes Software for Windows 95, 98, NT

PG302 Device List:
Atmel: 89C1051, 89C2051, 89C4051, 90S1200, 90S2313

Add the ADT87 Adapter to program:
AMD: 87C51, 87C52, 87C521, 87C541, Atmel: 89C51, 89C52, 89C55, 87F51, 87F52
Dallas: 87C520, Intel: 8751BH, 8752BH, 87C51, 87C51FA, 87C51FB, 87C52, 87C54
Phillips: 87C51, 87C51FA, 87C51FB, 87C52, 87C504, 87C524, 87C528, 87C550, 87C575, 87C576, 87C652, 87C654

Add the ADT90 Adapter to program:
Atmel: 90S4414, 90S8515, 89S53, 89S8252

Free Priority Mail Shipping!(US Orders)

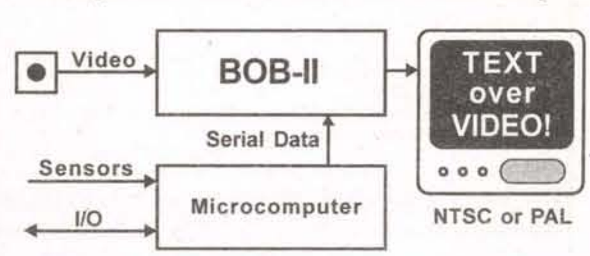
Order Online or call 1-800-297-1633

Iguana Labs
http://www.iguanalabs.com
sales@iguanalabs.com
tech@iguanalabs.com
(540) 951-7960
(800) 297-1633

www.iguanalabs.com

EASILY ADD TEXT TO VIDEO WITH BOB-II

- Auto-switching genlock overlay module
- Generates complete video signal on-board
- Up to 308 characters in 11 rows, 28 cols
- Fast 'RS-232' serial control (2400-19.2kbps)
- Small footprint; only 3.50" by 1.05"
- Developer board now available (BNAB)
- Compatible with Parallax™ BASIC Stamp™



Only $79.95 ea. (NTSC qty. 1~9)

DECADE ENGINEERING
Tel: 503.743.3194 ~ Fax: 503.743.2095
www.decadenet.com

TEST EQUIPMENT

FEITEK PROVIDES repair, calibration and traceable certifications of test equipment. Free estimates. We buy, sell and trade all makes of test equipment. Visa and MasterCard accepted. Check out our inventory and specials at WWW.FEITEK.COM 2752 Walton Road, St. Louis, MO 63114, 314-423-1770.

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

POOR MAN'S Spectrum Analyzer/Monitor Receiver Kit. 2 to 1,700 MHz. Basic kit only $98. Now available with switched resolution filters, tracking generator and direct digital frequency readout. Works with ANY scope or IBM compatible computer. Send stamped envelope for details. Science Workshop, Box 310B, Bethpage, NY 11714. http://www.science-workshop.com

 Write in 32 on Reader Service Card.

KENTRONIX TEST EQUIPMENT SPECIALS. Check our WEB site at **http://www.kentronix.com** for monthly specials. We are also looking to buy test equipment, coaxial and waveguide components, manuals, etc. Contact Brian at 732-681-3229 or FAX 732-681-3312. E-Mail: brian@kentronix.com

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

BROWSE OUR Web site and 'check out the "monthly special." TDL Technology, Inc., www.zianet.com/tdl

AFFORDABLE HP power sensor repair! Most 8481As repaired for $305 or less. We also handle 478As and many others. Call or fax for more information. Willamette RF, Inc., 541-754-7226, FAX 541-753-4629.

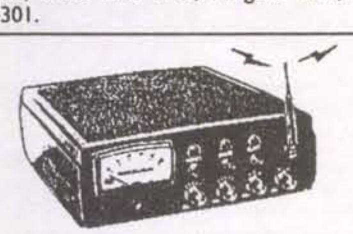
TEST EQUIP: GR 1308 $1,100; 1654 $700; 1382 $325; 1316 $750; 1425S $500. Call between 6-7pm 978-251-3855.

INVENTORY SALE: HP synthesized sweepers 8350A $800, $1,150; 11869A RF plug-in adaptor $400; 86222B opt. 002 $450; 86222A $325; 8015A pulse generator $175, opt. 003 $250; 3336C, 004/005 synthesizer & level generator $500; audio analyzer 8903A $475; 3403C TRMS DVM $100; 3325A opt. 1 & 2 $450; 436A power meter with cable $425; opt. 002 & 022 $675; synthesized sig. generator 001, 005, 100 $650; 86603A, opt. 002, $850; 86635A $500, system $1,675; HP 1142A probe control power module $125; HP 1980B oscilloscope measuring system $350; HP 3781B pattern generator $350; HP 3763A error detector $350; TEKTRONIX 492 opt. 002 $3,000; TM-501A $100 4 available; Tek TM-506 $125; TM-506A $150; TM-503 $75; TM-503B $100; Tek TM-2215 scope $350; 466 $350; Tek TM-178 IC test fixture $200. Call for others. **Psitech Plus** 707-745-4804.

MISC. EQUIPMENT: topward dual tracking DC power supply model TPS 4000 $300; HP 3456A 6 digit DMM $450; PTS std. freq. syn. 1-500MHz $250; .01-160 $175; DSI 7187 BIT ERROR TEST SET $250; 707-745-4804. Check our new www.psitech-plus.com

SECURITY

STOP THEM from listening in or recording your telephone conversations with the **TELEPRIVACY-PLUS**. Send $49 to Vakis, 1402 Pine Ave., Niagara Falls, NY 14301.

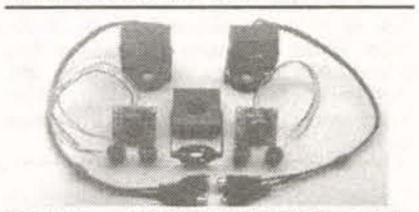


COUNTER-SURVEILLANCE=$250 HR! Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn **$250 HR** in the fascinating field of COUNTER-SURVEILLANCE! For FREE catalog call: **1-800-732-5000**.

SALE! PS 102 SMOKE DETECTOR: Built-in pin hole CCD, lens size: 3.6mm. **$89**. Matco, Inc., 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com

Write in 33 on Reader Service Card.

SURVEILLANCE-COUNTERSURVEILLANCE: I buy and sell used equipment. Steve 410-879-4035.



COLOR — LOW LIGHT CCD pin hole and standard lens available, only 1.27" x 1.27". $129, enclosure $10 extra. Sony sensor. Matco, Inc., 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com

AS-1004, FCC approved. 2.4GHz transmitter & receiver with audio! Capable handling total of 4 wireless cameras, range: >300'. Built-in camera, 400 TV line. **$219 per system.** Additional camera **$119** @ 10 pcs. Matco, Inc. 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com

SEEKING DISTRIBUTORS FOR SECURITY PRODUCTS. Matco, Inc., Schaumburg, IL 630-350-0299. www.mat-co.com

WIRELESS OBSERVATION SYSTEM w/built-in 5-1/2" monitor $239. Matco, Inc., Schaumburg, IL 1-800-719-9605. E-Mail: nsales@mat-co.com Web site www.mat-co.com

Write in 34 on Reader Service Card.

SINGLE CHIP COMPUTER!

- Zero External Components
- Built-in BASIC / Assembly
- RS232 Program Download
- 1K flash, 64ee, 3irq, 2timers
- 15 I/0 bits, A/D comparator
- 20mips, faster than pic/8051
- 20 pin DIP part #MV1200

$1.99 OEM (1K) EVAL KIT (1) $7.00

NEW! 8K SUPER CHIP

Improved BTERP with 40 times the BASIC program capacity
- 40 pin DIP part #MV8515 - 32 I/O, 12 irq, 3 timers, bus
- 8K flash, 512 ee, 512 nvram - Watchdog with internal osc.

$5.40 OEM (1k), Eval Kit $19.00

PC SOLID STATE DISK

$21 OEM (1k), EVAL $75
FLASH,NVRAM,ROM
256K-16M DIP/PCMCIA

$95 UNIVERSAL PROGRAMMER

FLASH,EPROM,NVRAM,EEPROM to 8meg (27080). Adapters for micros, PLCC, etc.. Parallel port version for notebooks. FAST and EASYTO USE.

PC WATCHDOG!

NO MORE HANGUPS..
Reboots PC on hardware or software hangup..
oem $21, eval $75

LCD VGA $27

OEM (1k), eval $95
640x480 controller
use with PC or SBC

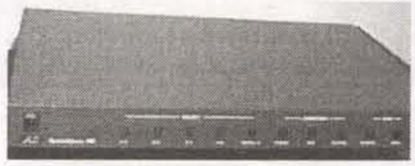
$27 MINI PC

$27 OEM, Eval $95, includes: DOS, 3 ser, 2 par, rtc, NVmem, Built-in LED display, ISA bus, Keyboard and LCD interfaces. COMPLETE !!!
Not a "core" or "engine". All utilities and tutorial included. Use Turbo C, BASIC, MASM. 386 version: $42 oem, $195 eval

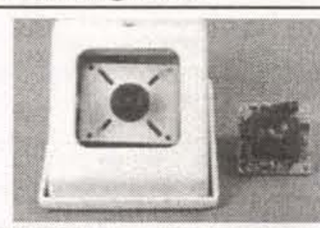
3"x4"

WWW.STAR.NET/PEOPLE/~MVS
MVS Box 850
Merr.,NH 03054
(508) 792 9507
MVS
5yr Limited Warranty
Free Shipping
Mon-Fri 10-6 EST

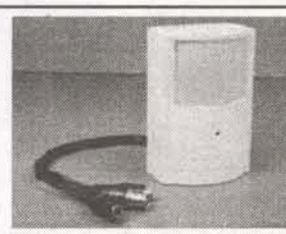
Write in 35 on Reader Service Card.



SECURITY CAMERA QUAD PROCESSOR: American Dynamic AD1476 real-time high-resolution B&W 2-page duo-quad. W/time + date generator, sequential switcher, titler, 2-video outs, full-screen playback. ADs top-of-the-line quad unit. A MUST for any home or business security camera sys. Industrial unit, not a toy. BNC ins + outs. This unit will take up to 8 cameras and display them in quad mode or full-screen. Dlr. cost **$575**. NOW **$225** w/1 yr. warranty, while supplies last. Also avail: AD1475A, **$175**; AD1474-4 cam quad, **$125**, and other multiplexers @ 40-60% off dlr. prices. Remember: Don't buy junk. Pro-Vid Systems, Woburn, MA. 781-933-0827. E-Mail: ricksvideo@msn.com

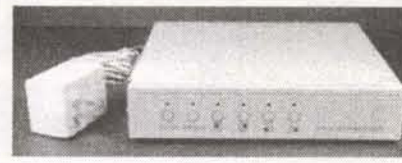


UNIVERSAL WEATHERPROOF ENCLOSURE for board cameras, fits all 30-42mm color/back & white cameras, **$39** qtys 1-4. Matco, Inc., Schaumburg, IL 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com

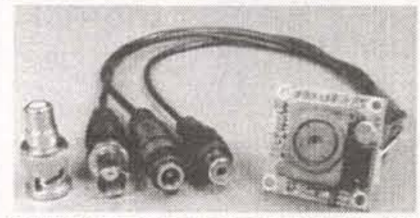


SPECIAL! IC 113: PIR motion detector with audio! **$89** @ 5 pcs. Matco, Inc. 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com

CONSUMERTRONICS 120+ exciting manuals: Electronics, computers, Internet, phones, energy, radionics, financial (including stocks), crime-fighting, security, survival, phenomena, **SPECIAL PROJECTS**. Catalog $3. PO Box 23097, Albuquerque, NM 87192. **www.tsc-global.com**

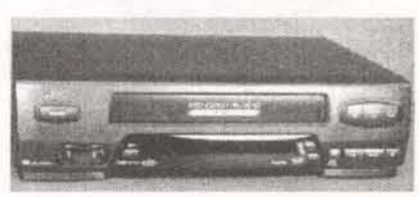


QUAD SYSTEM displays 4 cameras simultaneously. Special price **$119**. Matco, Inc., Schaumburg, IL 1-800-719-9605. E-Mail: nsales@mat-co.com Web site www.mat-co.com

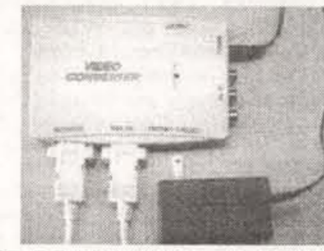


B/W BOARD camera w/audio, $49 @ qty 10, 1.27" x 1.27". Enclosure available for $10. Matco, Inc., 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com

B/W 430 LINE CCD CAMERA with optional black low-profile swivel adjustable enclosure. Pin hole or Std. lens type. 6, 8, and 12mm lens are available. 1/3" CCD, 3.6mm/F2.0 lens included; 9-14 VDC, 0.08 lux, IR sensitive; 1.27" x 1.27" x 0.5"D pinhole or 1" deep standard. Price @ 10 pcs., **$44 each**. Enclosure: $8; optional lens: $18. Dealers welcome. MATCO, Inc. 1-800-719-9605. Fax 847-619-0852. E-Mail: sales@mat-co.com Website: www.mat-co.com



40 DAYS and 40 NIGHTS RECORDER. TLR-6960 time lapse. Special price $519. Matco, Inc., Schaumburg, IL 1-800-719-9605. E-Mail: nsales@mat-co.com Web site www.mat-co.com



USE PC MONITOR AS SECURITY MONITOR. The VGA-801 accepts standard NTSC or PAL inputs for display on any existing VGA/SVGA computer monitor. Small compact size. Over 600 lines of resolution, twice that of standard TV monitor! **$69 each**. Dealers welcome. MATCO, Inc., 1-800-719-9605; Fax 847-619-0852; E-Mail: sales@mat-co.com Website: www.mat-co.com

SATELLITE EQUIPMENT

FREE BIG dish catalog. Low prices! Systems, upgrades, parts, and "4DTV." Skyvision, 1010 Frontier Dr., Fergus Falls, MN 56537. www.skyvision.com **Call 1-800-543-3025**.

BEST PRICING on 18" satellite TV systems for home and RV. DISH Network DirecTV, multi-room viewing options, accessories, more. www.skyvision.com **Call 1-800-543-3025**.

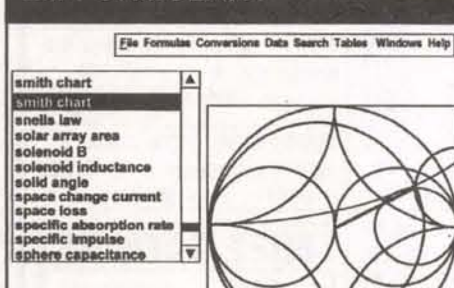
THE EASIEST way to recover your lost master code. 16C5X, 16C62X, PALs, GALs, other microcontrollers, custom ASICs. Check out our web page at www.acdinc.com for details or call 703-764-5361 or write: Advanced Circuit Designs, Inc., 5765-F Burke Centre Parkway #317, Burke, VA 22015.

Continued on page 55

A DEGREE ON A DISK!

Electro Science Applications Inc.

EM FORMULARY



- 500+ formulas and simulations
- Unit conversions and data tables
- Physical constants
- Electronics, communications, radar
- Antennas, filters, optics
- Physics, math, space science
- Practical and educational

Self-contained and intuitive, you'll be up and running in minutes. Fast menu and hyper-linked access to equations and data. Current version 1.7 works with Windows 3.1, 95, or 98.

ELECTRO SCIENCE APPLICATIONS, INC.
P.O. BOX 11158, TORRANCE, CA 90510

To order, call (310) 539-2422 or E-Mail esa@earthlink.net
Send $29.95 check or money order (CA residents add 8.25% sales tax).
Foreign orders add appropriate shipping charge.

Electronic and RF design services also available.
Visit us at http://www.esap.com

Weeder Technologies

VISA MasterCard

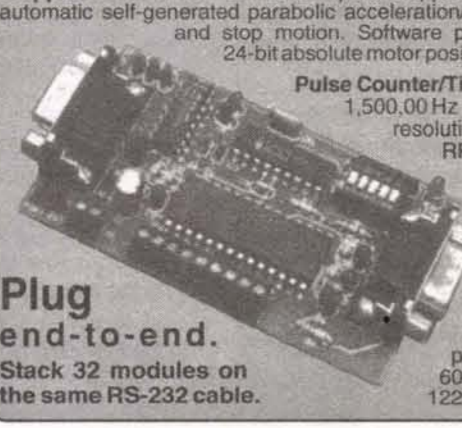
RS-232 Stackable

www.weedtech.com *Data Book Available* 850-863-5723

Digital I/O Module - 14 I/O pins individually configured for input or output. Turn on/off relays. Sense switch transitions, button presses, 4x4 matrix decoding using auto-debounce and repeat. One-shot pulse output with user programmable length. **$49**

Analog Input Module - 8 input pins. 12-bit plus sign self-calibrating ADC reads voltages from 0 to 4095 mV using 1 mV resolution. Supports single-ended, differential, or pseudo-differential modes. Software programmable alarm trip-points for each input. **$59**

Stepper Motor Driver - Drives a unipolar stepper motor rated up to 25VDC @ 2A. Uses automatic self-generated parabolic acceleration/deceleration curves for smooth start and stop motion. Software programmable ramp-rate and speed. 24-bit absolute motor position counter. Limit-switch input. **$59**

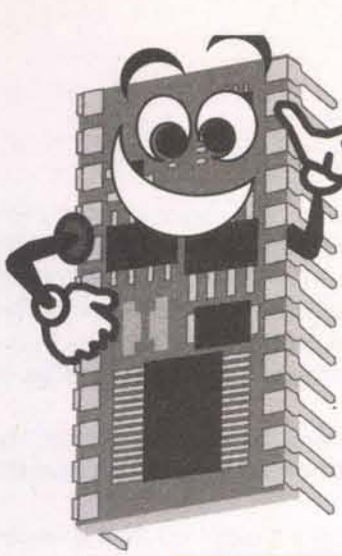


Pulse Counter/Timer - Read frequency from 0.50000 to 1,500,00 Hz using floating decimal point and 5-digit resolution throughout range. Measure period, RPM, duty cycle, pulse length, velocity of a projectile using a pair of trip wires. Accumulate pulse count. **$69**

Multi-Drop Peripheral Interface Plug a third-party RS-232 peripheral into the multi-drop bus. Appended header character allows PC to exclusively communicate with each of up to 32 devices. Supports peripheral baud rates of 75, 150, 300, 600, 1200, 1800, 2400 and 9600. Built-in 122-byte FIFO RAM buffer. **$59**

Plug end-to-end.
Stack 32 modules on the same RS-232 cable.

Write in 36 on Reader Service Card.



by Jon Williams

Stamp Applications

Calling All Stamps

Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips

Today, modems are ubiquitous and we take them for granted. Our access to the Internet is enabled with modems and yet, we hardly give it a thought. I write these articles in Texas and, using my modem, send them off to California for publication. The point is, our big blue world has been made quite a bit smaller by connecting devices with modems. So ... how might we use one with a Stamp?

I remember my first modem ... What a beauty: a 300-baud brick of a device that plugged right into the back of my trusty Commodore 64. On its first day of operation, I used that modem to chat with my friend, Bruce, who lived about 20 miles away. We stayed up almost all night typing messages back and forth to each other. It was horribly inefficient — as far as communication goes — but it was just so darned cool; our computers could talk to each other. Not long thereafter, we discovered uploading and downloading. The world had suddenly become a much brighter place.

The BASIC Stamp is a great tool for data collection and control. Its ease of programming, I/O, and built-in serial capabilities make it a great lab tool that can be connected to a host PC. But what if the Stamp data-collector and the PC are not located in the same room or, better yet, you want to talk to several remote devices?

As we've seen, it's really not a problem; all we need is a modem. There are applications all over the Internet that demonstrate connecting a modem to the Stamp. The problem, thus far, has been packaging. How does one neatly package a salvaged modem with the Stamp? It can be a bit tricky, especially if you want one nice, neat, small box in your remote location.

A California-based company called Cermetek (www.cermetek.com) has solved the packaging problem with their line of embedded modems. These modems are very small — not much bigger than a BS2. And, like the BS2, they're configured as DIP (albeit 0.8") packages. The modem that we'll use in our application is the Cermetek CH1786, which is available in an App Kit directly from Parallax.

CH1786 Basics

For review, the purpose of a modem is to allow two computers to "talk" to each other over some form of remote connection; usually, but certainly not limited to, telephone lines. In its most basic form, this is accomplished by converting the serial stream of ones and zeros to tones that are compatible with telephone line standards. This is called modulation. The receiving modem converts these tones back to ones and zeros. This is called demodulation. Hence, the term, modem. It's a contraction for modulation/demodulation.

Phone modems also provide an important electrical interface to the telephone line. This is called a Data Access Arrangement (DAA). Keep in mind that the telephone companies are justifiably fussy about devices that are connected to their lines. The CH1786 includes an FCC approved DAA. Even with the approved DAA, it is recommended that protective devices be installed between the modem and the telephone jack. That will reduce the chance of a surge coming in from the telephone lines (pretty common occurrence in high-lightning areas) from damaging the CH1786. The nice thing about using the Cermetek modem is that you can put it into a commercial device without going through the rigors and considerable expense of an FCC evaluation.

Like the Stamp, modems are "smart" devices and will respond to commands. The CH1786 is no exception. The list of commands is referred to as the "AT" (for attention) command set and was originally developed by Hayes for its modems. All modem manufacturers have adopted the AT command set (with modifications). With the sophistication of current modems, the AT command set is very broad and, unfortunately, not always universal. Thankfully, we only need a few of the basic commands for our project.

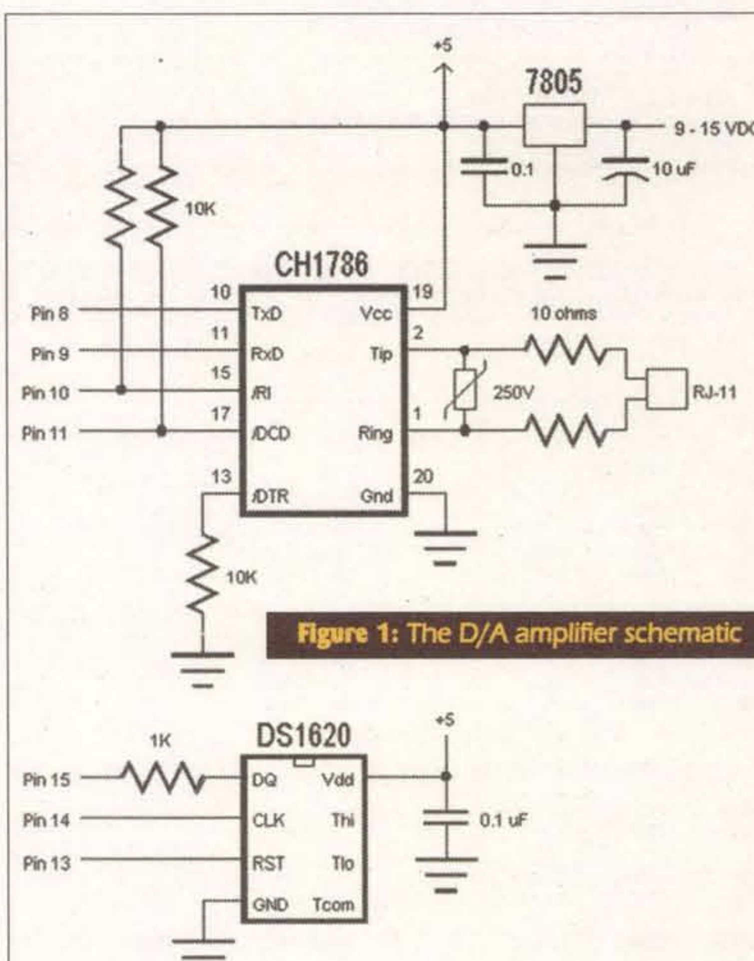


Figure 1: The D/A amplifier schematic

Calling All Stamps

Our Project: A Remote Temperature Monitor

Our demonstration project is a simple recording thermometer — a remote recording thermometer. It constantly scans a Dallas Semiconductor DS1620 digital thermometer and records the current, high, and low values. We'll get the data from the Stamp by calling it with a terminal program.

When a call is detected by the modem, the line is answered and the temperature information is sent to the user's remote terminal. From the remote location, the user is able to refresh the temperature display and even reset the stored high and low temperature values.

To keep things simple, we'll use a general-purpose terminal program (such as Windows® Terminal) as our remote access. But keep in mind that your terminal program does not have to run on Windows®. That's one of the neat things about the remote contact part of this project: the user can be running any operating system. The only requirements of the terminal program are that it runs ANSI emulation and can dial into your Stamp project through the remote computer's phone modem.

About the Circuit

With my typical adherence to the "KISS" theory (Keep It Simple, Silly), the circuit is very straightforward. Four lines are used to connect the Stamp to the CH1786: TX (transmit), RX (receive), RI (ring indication), and DCD (data carrier detect).

A quick scan through the code will show that we're not even using the Ring Indicator — it's there for possible future use.

The reason is because the RI line does not go low and stay low during the ring, it actually pulses (low-high transitions) at a 20 to 30 Hz rate (corresponds with the ringing sound and is probably there to allow your processor to detect distinctive ringing where available). The code includes a short sub-routine for dealing with the pulsing RI line should you want to use this input in your projects (more later).

So how will we know when the user is calling? The DCD line will tell us. This input goes low when the remote user has called in and the two modems are "hooked up." It's very convenient. You might wonder then, why bother with the Ring Indicator? One possible reason is to use it as a sort of warning. By detecting the ring, critical processes could be finished before the modem answers and has to deal with the remote connection. You might also decide to ignore a call based on current conditions. In our case, we're going to tell the modem to answer the phone and let us know when everything is connected.

The DS1620 is connected with a standard three-wire interface. The clock and data signals can be shared with other devices that use the same three-wire bus.

Also notice that an external power supply is required. This is important. In operation, the modem draws more current than the Stamp can provide. A simple three-terminal regulator gives us the necessary five volts from a junk-box DC power supply.

The Software

The general structure of the software is a task switcher. In operation, a task switcher works like this:

- Do maintenance
- Do a task
- Do maintenance
- Do another task ...

This design allows the program to be broken up into small, manageable tasks that don't take a long time to run. This is important in our design since we want to keep tabs on the DCD indication. We'll put that in the maintenance section.

When using the task switcher design, there are two choices for updating the task control variable: in the maintenance section (before the **BRANCH** command) or individually within each task. The method used here is the latter; the task variable is updated by the current task. This allows the system to be more dynamic. For example, a task might use the state of an input pin to determine which task will run next.

To new programmers, designing a program in this manner may

```
' Nuts & Volts - Stamp Applications
' April 2000

' -----[ Title ]-----------------------------------------------
'
' File...... CERMETEK.BS2
' Purpose... Cermetek CH1786 demo program
' Author.... Jon Williams
' E-mail.... jonwms@aol.com


' -----[ Program Description ]---------------------------------
'
' This program monitors a Dallas Seminconductor DS1620 digital thermometer
' while waiting for an incoming call. When a call is received, the Stamp
' causes the modem to answer the call then displays temperture data on
' the remote terminal.


' -----[ I/O Definitions ]-------------------------------------
'

' modem pins
'
TX1      CON     8                 ' transmit to modem
RX1      CON     9                 ' receive from modem
RI_      VAR     In10              ' ring indicator
DCD_     VAR     In11              ' carrier detect

' DS1620 pins
'
Rst      CON     13                ' DS1620.3
Clk      CON     14                ' DS1620.2
DQ       CON     15                ' DS1620.1


' -----[ Constants ]-------------------------------------------
'
True     CON     1
False    CON     0

No       CON     1
Yes      CON     0

T2400    CON     396               ' 2400 baud for modem

LF       CON     10                ' line feed character
FF       CON     12                ' form feed (clear remote screen)


' DS1620 commands
'
RTmp     CON     $AA               ' read temperature
WTHi     CON     $01               ' write TH (high temp register)
WTLo     CON     $02               ' write TL (low temp register)
RTHi     CON     $A1               ' read TH
RTLo     CON     $A2               ' read TL
Strt     CON     $EE               ' start conversion
StpC     CON     $22               ' stop conversion
WCfg     CON     $0C               ' write configuration register
RCfg     CON     $AC               ' read configuration register


NTasks   CON     3                 ' total number of tasks


' -----[ Variables ]-------------------------------------------
'
tmpIn    VAR     Word              ' 9-bit temp input from DS1620
nFlag    VAR     tmpIn.Bit8        ' negative flag
hlfBit   VAR     tmpIn.Bit0        ' half degree C bit
tempF    VAR     Word              ' converted fahrenheit value
tempC    VAR     Byte              ' converted celcius value
tmpNow   VAR     Word              ' current temperature
tmpLo    VAR     Word              ' low temp
tmpHi    VAR     Word              ' high temp

sign     VAR     Byte              ' - for negative temps
sLo      VAR     Byte
sHi      VAR     Byte

inByte   VAR     Byte              ' input from user terminal
cmd      VAR     Byte              ' command pointer
answer   VAR     Byte              ' user response to prompt

task     VAR     Byte              ' task control variable

riFltr   VAR     Byte              ' for ring indicator filter


' -----[ EEPROM Data ]-----------------------------------------
'
```

seem like a lot of work. It really isn't, once you've tried it and — I promise — it will make your programs easier to deal with as they become more sophisticated, and much more flexible when you need to make a design change.

All right, let's look at our code. We start by setting our **Dirs** (I/O direction) which, in this program, are not actually necessary because the various Stamp commands will set the pins appropriately. It's still a good idea though, if only a reminder to you as to what each pin is doing.

The saved high and low temperatures are set to their opposite extremes. We do this so that these values will be reset to the current temperature on the first scan of the DS1620.

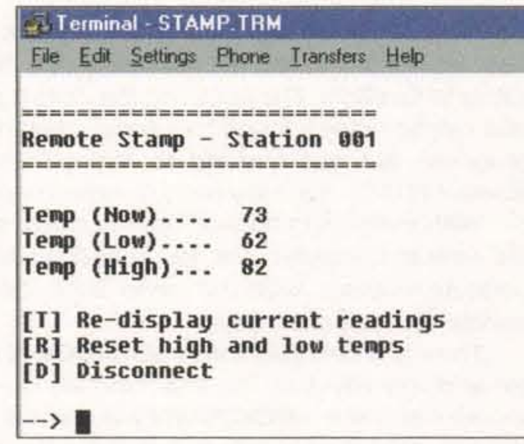
Initializing the modem is handled in two sections. First, we train the modem for speed by sending "AT" and a carriage return at the baud rate we want to use (up to 2400 baud for the Cermetek CH1786). Since we're connecting directly to the modem, we use a "true" (non-inverted) connection. In the Constants section, you'll find we've defined T2400 to make the program easier to read.

Our **SEROUT** command to the modem includes the pacing parameter. This is important on command strings, especially when they get long (the CH1786 will allow up to 40 characters in a command string). If everything works, the modem should respond by sending back "OK." You'll see a **SERIN** line after our commands. This is to ensure the modem is working. If the modem does not respond with "OK" within two and a half seconds, the program will jump to a routine called **Error** (once we get past the initialization section, we'll assume the modem is fine and stop "listening" for "OK").

The error handler doesn't actually do anything except wait for one second, then jump back to the initialization section to try again. You could enhance this code by illuminating an error indicator. Just be sure to turn off your error indicator when the modem does initialize.

Most of a modem's behavior is controlled by values stored in what are called "S registers." There are dozens of S registers. Thankfully, we only need to worry about two. The first, S0, allows the modem to answer the phone line if set to a value greater than zero. We'll use two.

The second register that we're concerned with is S7. This register determines how long the modem will wait for a carrier from the remote device once it's answered the phone. Thirty seconds should be long enough for the two devices to connect. Don't ignore this setting. I did while experimenting and found that when this register wasn't set, my project would never let go of the phone line when a call had been answered.



Once the modem is working, we'll fire-up the DS1620. Interestingly, it also communicates serially with the Stamp but, in this case, it's synchronous serial communications. What this means is that the Stamp must provide a clock signal with the data. The BS2 commands **SHIFTOUT** and **SHIFTIN** take care of this very nicely.

The first thing we do with the DS1620 is tell it that we're writing to it. Once we've done that, we send the configuration byte. Our set-up is for use with a CPU (that is, we're going to retrieve data from it) and to use free-run mode (continuously scan temperature). With our configuration byte sent, we have to release the DS1620 momentarily so that it can be stored in the DS1620's EEPROM. This takes about 10 milliseconds. With that done, we send it the command to start running. Pretty easy stuff.

Okay, now we're into the heart of the code. The first part (maintenance section) gets the current temperature and updates the stored values. Calling ScanT does this. This routine connects with the DS1620 and retrieves the current temperature. The temperature comes back as a nine-bit value that is actually expressed in 0.5 degrees (Celsius) increments. In our program, a call to **GetF** will take care of the conversion to Fahrenheit. If you want to stick with Celsius, change the call to **GetC**. Both of these routines deal with converting the DS1620 data to whole number values and setting the sign appropriately. Once we've got our current temperature, we update stored high and low values, if necessary.

```
' -----[ Initialization ]----------------------------------------
'
Init:   Dirs = %0110000100000000
        tmpLo = $FFFF             ' start with opposite extremes
        tmpHi = 0

I_Modm: PAUSE 250                 ' allow modem to power up

        ' train modem for speed
        '
        SEROUT TX1, T2400, 10, ["AT", CR]
        SERIN  RX1, T2400, 2500, Error, [WAIT ("OK")]
        PAUSE 250

        ' auto answer on second ring (S0=2)
        ' set max time for carrier detect to 30 secs (S7=30)
        '
        SEROUT TX1, T2400, 10, ["ATS0=2 S7=30", CR]
        SERIN  RX1, T2400, 2500, Error, [WAIT ("OK")]

I_1620: HIGH Rst                              ' alert the DS1620
        SHIFTOUT DQ,Clk,LSBFIRST,[WCfg]   ' write configuration
        ' use with CPU; free run mode
        SHIFTOUT DQ,Clk,LSBFIRST,[%00000010]
        LOW Rst
        PAUSE 10                  ' pause for DS1620 EE write cycle
        HIGH Rst
        SHIFTOUT DQ,Clk,LSBFIRST,[Strt]   ' start temp conversions
        LOW Rst

NoDCD:  IF DCD_ = Yes THEN NoDCD ' make sure DCD is clear


' -----[ Main Code ]-------------------------------------
'

Main:   GOSUB ScanT                       ' get current temperature
        IF DCD_ = Yes THEN GetMdm         ' call received

        BRANCH task, [Task0, Task1, Task2]
        GOTO Main

Task0:          ' task code here
        '
        task = 1                          ' select a specific task
        GOTO NextT                        ' go do it

Task1:          ' task code here
        '
        task = 2
        GOTO NextT

Task2:          ' task code here
        '
        task = 0
        GOTO NextT

NextT:          ' task = task + 1 // NTasks         ' round-robin to next task
        GOTO Main

        END


' -----[ Subroutines ]-------------------------------------
'


' ==============
' Modem Routines
' ==============

' error with modem
' - structured as seperate routine to allow user indications/enhancements
'
Error:          ' additional code here
        PAUSE 1000
        GOTO I_Modm                           ' try to initialize again


GetMdm: PAUSE 5000                            ' let other end get ready
Modm1:  GOSUB DoMenu                          ' show readings and menu
Get1:   SERIN RX1, T2400, [inByte]            ' wait for input

        ' process user input
        cmd = 99
        ' convert letter to digit (0..5)
        LOOKDOWN inByte, ["tTrRdD"], cmd
        cmd = cmd / 2                         ' fix for BRANCH
        ' branch to handler
        BRANCH cmd, [Cmd0, Cmd1, Cmd2]
        GOTO Modm1

Cmd0:   GOSUB ScanT                           ' get current temp
        GOTO Modm1
Cmd1:   GOSUB RstT                            ' reset high and low
```

Calling All Stamps

Next, we check the DCD line. If it's low, the modem has answered and we can talk to the remote device. On detecting DCD, the program jumps to **GetMdm**. The first thing this does is pause a bit so that the other end can be ready. I found that some combinations of modems/terminal programs did not respond to the carrier detection as fast as the Stamp/CH1786. You may need to experiment with the **PAUSE** value.

With everything hooked up and ready, the Stamp sends a menu to the remote computer. The menu displays our current and stored temperature readings. With the menu displayed, the program waits for the remote user to press a key.

The key is decoded with a **LOOKDOWN** command. This code is simple and very effective. The first thing we do is set the variable cmd to a known bad value. **LOOKDOWN** will convert a valid key (upper or lower case) to a value from zero to five. If the key is not valid, cmd will not be changed. Since we only have three things to do, but have six possible cmd values, we divide the command by two. This fixes it for the **BRANCH** command. If the key was bad, cmd will not work in the **BRANCH** command (its value exceeds the range of options) and the program will loop back to get another key.

If the remote user presses "t" or "T," the program will go get the current temperature and redisplay the menu.

If the user presses "r" or "R," the program will prompt the user for a confirmation before resetting the stored high and low temperatures. The confirmation is handled by a routine called **YesNo**. This routine will display the prompt, "Are you sure? (Y/N) : " and then wait for up to five seconds for the user to respond. If the user does not respond or presses a key other than "y" or "Y," the answer variable is set to No and the program resumes.

The menu choice of "d" or "D" (for disconnect from session) is handled in the same manner.

Extending the Project

There are several logical extensions to this simple project. The first would be the addition of a real-time clock (i.e., DS1302) to record the time and date of the high and low temperature values. The Stamp might also collect the state of other inputs at the time of the temperature recordings. Finally, you might take advantage of the modem's ability to dial out by sending an emergency message to the user's pager (see below).

For advanced applications, a specialized terminal program could be developed. This would be simply for sending and receiving large amounts of data. Such a program could, for example, be set up to automatically poll the remote Stamps and record the readings to a hard disk. The RTCs in the remote units could be checked and automatically synchronized with the PC. The possibilities for custom applications are endless.

Resources:

Jon Williams
3718 Valley View Lane, #3040
Irving, TX 75062
(972) 659-9090
jonwms@aol.com

Parallax
599 Menlo Drive, Suite 100
Rocklin, CA 95756
(888) 512-1024
www.parallaxinc.com

Cermetek
406 Tasman Drive
Sunnyvale, CA 94089
(408) 752-5000
www.cermetek.com

For more information on the Cermetek modem, download files **ch1786.pdf** and **atcmd1.pdf** from the www.nutsvolts.com ftp library.

Sending Data to a Pager

Access to most numeric pagers is incredibly easy: dial the pager service, wait for the service to be ready, then punch in a set of numbers on the telephone keypad. This can be accomplished with a modem. The trick is to keep the modem in "command" (dialing) state so that DTMF digits can be sent to the pager service. You can do this by adding a semicolon to the end of the telephone number.

This bit of code will send "911" to a digital pager:

```
Pager:   SEROUT TX1, T2400, 10, ["ATDT123-456-7890;", CR]
         PAUSE 10000 ' let service answer and get ready
         ' send the numbers
         SEROUT TX1, T2400, 10, ["ATDT911", CR]
         PAUSE 5000 ' let number be dialed
```

```
        GOTO Modm1
Cmd2:   GOSUB Discon                          ' disconnect from user
        IF answer = No THEN Modm1             ' stay with user
        GOTO NoDCD                            ' back to the beginning


' clear remote terminal and display menu
'
DoMenu: SEROUT TX1, T2400, [FF]
        SEROUT TX1, T2400, ["==========================", CR, LF]
        SEROUT TX1, T2400, ["Remote Stamp - Station 001", CR, LF]
        SEROUT TX1, T2400, ["==========================", CR, LF]
        SEROUT TX1, T2400, [LF]
        SEROUT TX1, T2400, ["Temp (Now).... ", sign, DEC tmpNow, CR, LF]
        SEROUT TX1, T2400, ["Temp (Low).... ", sLo,  DEC tmpLo, CR, LF]
        SEROUT TX1, T2400, ["Temp (High)... ", sHi,  DEC tmpHi, CR, LF]
        SEROUT TX1, T2400, [LF]
        SEROUT TX1, T2400, ["[T] Re-display current readings", CR, LF]
        SEROUT TX1, T2400, ["[R] Reset high and low temps", CR, LF]
        SEROUT TX1, T2400, ["[D] Disconnect", CR, LF]
        SEROUT TX1, T2400, [LF, "--> "]
        RETURN


' reset high and low temperatures
'
RstT:   SEROUT TX1, T2400, [CR, LF, LF, "Reset? "]
        GOSUB YesNo
        IF answer = No THEN RstX
        GOSUB ScanT
        tmpLo = tmpNow
        sLo = sign
        tmpHi = tmpNow
        sHi = sign
RstX:   RETURN


' disconnect
'
Discon: SEROUT TX1, T2400, [CR, LF, LF, "Disconnect? "]
        GOSUB YesNo
        IF answer = No THEN DiscX
        SEROUT TX1, T2400, [CR, LF, LF, "Disconnecting.", CR, LF]

        ' return modem to command state
        '  and hang up
        '
        PAUSE 2000
        SEROUT TX1, T2400, ["+++"]
        PAUSE 2000
        SEROUT TX1, T2400, 10, ["ATH0", CR]
DiscX:  RETURN


' confirm for [Y]es or [N]o
'   and get user input (default = No)
'
YesNo:  SEROUT TX1, T2400, ["Are you sure? (Y/N) : "]
        answer = No

        ' get answer
        ' - but only wait for 5 seconds
        '
        SERIN RX1, T2400, 5000, YesNoX, [inByte]
        IF inByte = "y" THEN IsYes
        IF inByte = "Y" THEN IsYes
        GOTO YesNoX
IsYes:  answer = Yes
YesNoX: RETURN


' process ring indicator
' - filters pulsing ring indicator
' - waits for about 0.25 second of no RI pulsing before returning
'
DoRing: ' your code here
        '  (i.e., count number of rings)
        '
RIWait: riFltr = 0                        ' clear the "no pulses" counter
RIchk:  IF RI_ = Yes THEN RIWait          ' still pulsing
        riFltr = riFltr + 1               ' not pulsing, increment count
        IF riFltr > 50 THEN RIx           ' RI clear now
        PAUSE 5                           ' 5 ms between RI scans
        GOTO RIchk                        ' check again
RIx:    RETURN                            ' done - outta here


' ===============
' DS1620 Routines
' ===============

' get current temperature
' -- update high and low readings
'
```

Calling All Stamps

```
SEROUT TX1, T2400, ["+++"]
PAUSE 2000
SEROUT TX1, T2400, 10, ["ATH0", CR] ' hang up
RETURN
```

Some pager services expect a terminating character (usually '#'). If this is the case with your service, simply add it to the message string:

```
SEROUT TX1, T2400, 10, ["ATDT911,#", CR]
```

The comma inserts a small delay (which is programmable in the modem through the S8 register) between the message numbers and the terminating character.

The code listing above is for example only; I don't suggest that you embed operational data this way. A better way to go would be to store your pager service number(s) and possible message in DATA statements. Then call a subroutine that points to the stored pager service number and message.

A final note on sending messages to pagers: Some paging services are finicky about DTMF dialing speed, that is, the duration of each digit in the dial string. The CH1786 has a default dialing speed of 95 milliseconds for each digit. This should work for most systems. If you find, however, that your system is not being dialed correctly or digits are missing from the transmission string, you can adjust the dialing speed with the S11 register. To change the dialing speed to 125 milliseconds, you can add this line to the modem initialization section:

```
SEROUT TX1, T2400, 10, ["ATS11=125", CR]
```

Sending text messages to an alphanumeric pager is a substantially more involved procedure, so much so that it may not be possible to do with the current line of Stamps (I haven't tried myself). If you're interested, download the Telelocator Alphanumeric Protocol (TAP) from www.motorola.com.

Wrap Up

Just when you thought SERIN and SEROUT across wires on your bench was cool, we've demonstrated that connecting to a remote Stamp across a telephone network is pretty easy too. And, with Cermetek's line of embedded modems, professionally packaging our project is not an issue. As an example of what can be done with a Stamp 2 and a Cermetek modem, take a look at www.hotwireftx.com ...

So what's next? Well, I've got some ideas but I'd really rather hear from you. Feel free to put your computer's modem to work and send your suggestions via E-Mail. **NV**

Suggested Reading:

I consider these "must have" books for any Stamp programmer:

Programming And Customizing The Basic Stamp Computer
by Scott Edwards
www.seetron.com
ISBN 0-07-913684
(paperback)
Also available from Parallax

Scott's book has a great project that allows you to control X-10 devices remotely using a modem and simple terminal program.

Serial Port Complete
by Jan Axelson
www.lvr.com
ISBN 0-9650819-2-3

If you want to learn the nitty-gritty details of serial communications, this is the book for you. Everything you need to know to roll your own communications programs. It even has a large section devoted to Stamps.

```
ScanT:  HIGH Rst                           ' alert the DS1620
        SHIFTOUT DQ,Clk,LSBFIRST,[RTmp]    ' read temperature
        SHIFTIN DQ,Clk,LSBPRE,[tmpIn\9]    ' get the temperature
        LOW Rst
        GOSUB GetF                         ' convert to Farhenheit
        tmpNow = tempF
        IF (tmpLo < tmpNow) THEN THigh
        tmpLo = tmpNow                     ' set new low
        sLo = sign
THigh:  IF (tmpHi > tmpNow) THEN TDone
        tmpHi = tmpNow                     ' set new high
        sHi = sign
TDone:  RETURN


' convert reading from 1/2 degrees input (rounds up)
'
GetC:   IF nFlag = 0 THEN CPos             ' check negative bit (8)
        sign = "-"                         ' set sign
        tempC = -tmpIn / 2 + hlfBit        ' if neg, take 2's compliment
        GOTO CDone
CPos:   sign = " "
        tempC = tmpIn / 2 + hlfBit
CDone:  RETURN


' convert (1/2 degrees C) to Fahenheit with rounding
' -- general equation (for whole degrees): F = C * 9 / 5 + 32
'
GetF:   sign = " "
        IF nFlag = 0 THEN FPos1
        tmpIn = -tmpIn & $FF                  ' convert from negative
        IF tmpIn < 36 THEN FPos0
FNeg:   sign = "-"
        tempF = tmpIn * 9 / 10 + hlfBit - 32
        GOTO FDone
FPos0:  tempF = 32 - (tmpIn * 9 / 10 + hlfBit)
        GOTO FDone
FPos1:  tempF = tmpIn * 9 / 10 + 32 + hlfBit
FDone:  RETURN
```

TEMPERATURE MEASUREMENT AND CONTROL

by Ron Tipton

For most people, the comfort zone is a fairly narrow temperature range centered more-or-less around 75 degrees F (23.9° C), which we often call "room temperature." Some of our electronic instruments are even more demanding. Crystal oscillators need a closely controlled temperature for best frequency stability. Standard cells and Zener diode voltage references also perform best in a temperature stable environment.

•

In this article, we'll take a cruise through this interesting realm and look at some of the devices we use to measure and control temperature. I have summarized the most pertinent information in a Comparison Table for easy reference.

THE MECHANICAL THERMOSTAT

With the advent of electric utility companies, central heating and cooling started to appear in our living and work spaces. And we needed some means for automatically turning the heat or cooling on and off at our choice of temperature. The bimetallic strip thermostat was invented to do this job.

You can make a bimetallic strip by attaching to each other two strips of material with different expansion coefficients, such as brass and iron as shown in Figure 1. When the strip is heated, the brass lengthens more than the iron. This curls the strip away from the "cold" contact, breaking the circuit and turning off the heater. This simple mechanical device is so reliable that it's still a widely used temperature controller in homes and offices.

But this thermostat needs hysteresis (as do all on-off controllers). That is, when used for heating, the temperature at which the contacts open must be higher than the temperature at which they close. This provides a "coarser" degree of control, but keeps the contacts from rapidly opening and closing at the set-point temperature. In fact, some early thermostats (1930s) didn't have any mechanical hysteresis and had to be used with a time delay to keep the heat on long enough to get a several degree control range. Hysteresis in a typical heat cycle is shown in Figure 2.

For cooling, the temperature at which the contacts open has to be lower than the temperature at which they close. This is done by using the common and "hot" contact as shown in Figure 1.

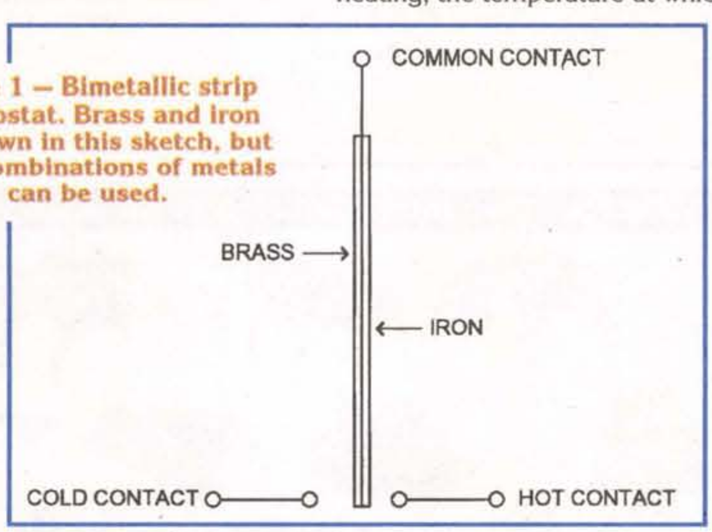


Figure 1 — Bimetallic strip thermostat. Brass and iron are shown in this sketch, but other combinations of metals can be used.

MERCURY THERMOSTAT

Mercury has a pretty linear thermal expansion coefficient over the temperature range we're usually interested in, so mercury makes a good thermometer. Because of cost and environmental concerns, mercury has mostly been replaced by other fluids in "room" thermometers. But laboratory thermometers still use mercury although electronic units with comparable accuracy are available. Digital thermometers are easier to read, too.

Back in the 1960s, mercury column thermostats were sometimes used in lab applications. For example, they were used to control the temperature of the outer "box" in a two-stage constant temperature enclosure. Platinum wires were sealed into the glass capillary tube to make electrical contact with the mercury column. They were very reliable as long as the current was kept small, generally less than five milliamperes, so arcing never occurs.

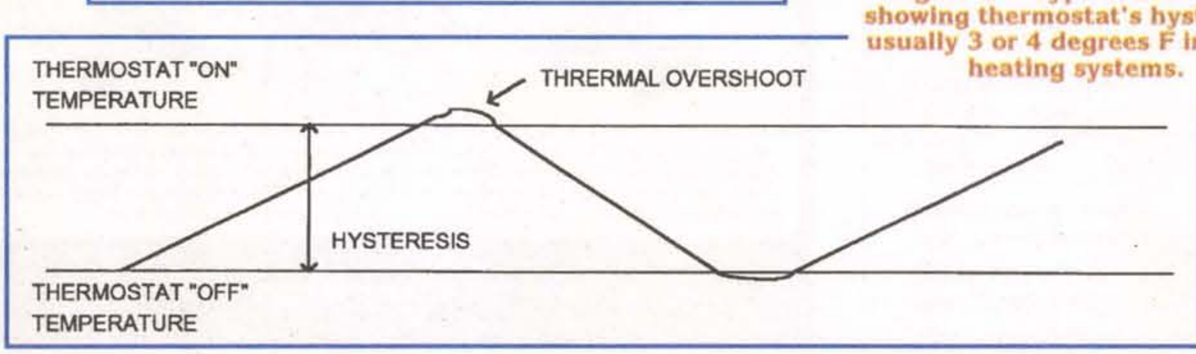


Figure 2 — Typical heat cycle showing thermostat's hysteresis, usually 3 or 4 degrees F in home heating systems.

THERMOCOUPLES

You can make a thermocouple by joining wires of different metals as illustrated in Figure 3. When the joints (or junctions) are at different temperatures, a voltage is produced which is proportional to the temperature difference.

Many kinds of wire can be used, but certain combinations have been standardized and there are tables of their output voltage vs. temperature (ANSI-MC96.1-1982). Two of the more common combinations are copper-Constantan (type T) and Chromel-Alumel (type K). Copper-Constantan has the advantage that the wires to the voltmeter can be low-resistance copper without introducing another junction between different metals.

Traditionally, the cold junction is held at 0°C in a melting ice bath and voltage-temperature tables are usually based on this assumption. But this is inconvenient (or impossible) in many applications, so the usual practice is to let the cold junction follow "room temperature" and compensate electronically for the difference above 0°C.

Thermocouples have a low output voltage (about 40 microvolts per degree C for type K) so they must be used with a stable, high input-resistance voltmeter or data acquisition system. But they are very rugged and are the only temperature sensor usable at very high temperatures — almost to the melting point of the wires. And, except for the types using an exotic metal (platinum), they are fairly inexpensive so their use continues.

THERMISTORS

Thermistors are bulk-type passive semiconductors. That is, they are made of a homogenous material, usually metal oxides.

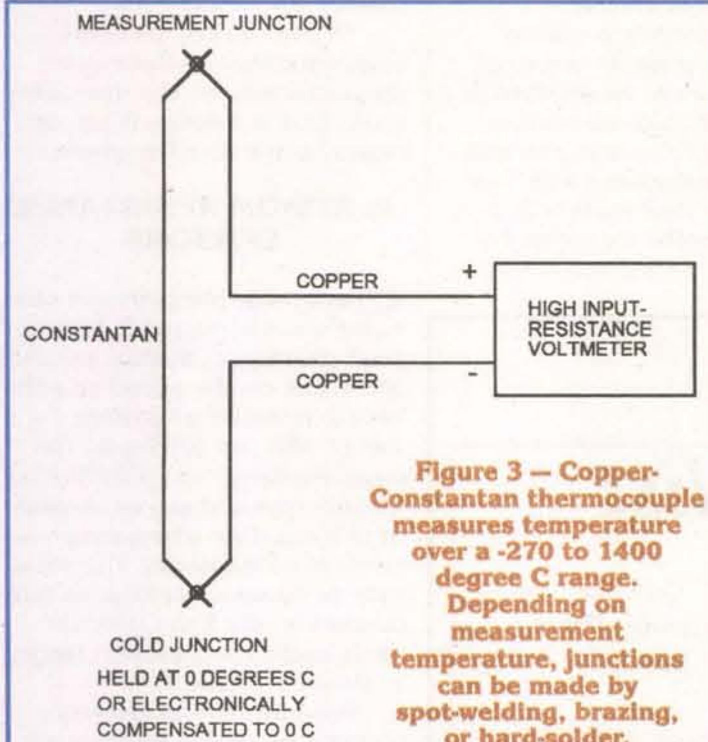


Figure 3 — Copper-Constantan thermocouple measures temperature over a -270 to 1400 degree C range. Depending on measurement temperature, junctions can be made by spot-welding, brazing, or hard-solder.

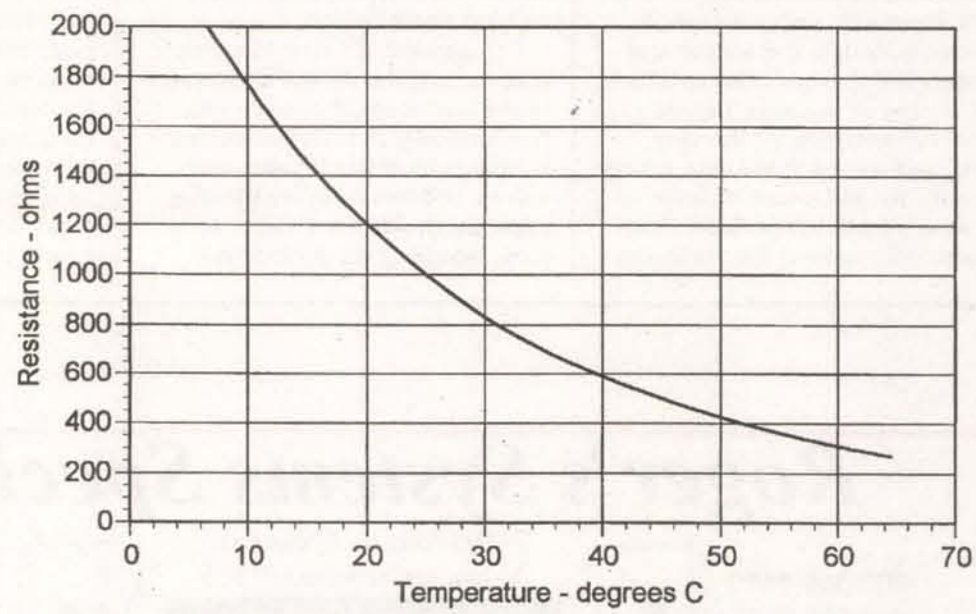


Figure 4 — Resistance-temperature curve for a typical NTC probe thermistor (Fenwal 121-102EAJ).

They exhibit a large change in resistance for a relatively small change in body temperature. Negative temperature coefficient (NTC) thermistors are usually used for temperature measurement and control because of their larger thermal coefficient as compared to their positive temperature coefficient cousins.

Because they are bulk devices, they can be fabricated in many shapes and sizes: from 0805 surface mount to large rods. Small beads and glass encapsulated probes are common in electronic applications. A typical resistance vs. temperature curve is included in Figure 4.

Thermistors have been the temperature measurement and control "work horse" for many years. They are rugged and inexpensive and about the only precaution in their use is to keep the current flow small enough to avoid self-heating. A thermometer can be as simple as an ohmmeter measuring the thermistor's resistance. Instead of ohms, the meter can be calibrated in degrees Fahrenheit or Celsius.

Thermistors are also common as the sensing component in temperature control circuits for oscillators, etc. There are as many different controller circuits as there are designers with the circuits generally falling into one of two basic types. Type 1 is direct, proportional DC control; an example circuit is shown in Figure 5. Let's look at how it works.

When the circuit is turned on, the thermistor, R6, is "cold" and the differential input voltage applied to A1 is more than three volts. A1 has a gain of 100 so its output is driven into saturation, about 6.75 volts. The voltage at pin 5 of A2 is now about 0.39 volt due to the voltage divider R8, R9. The high open-loop gain of A2 forces the inverting input voltage (pin 6) to follow the pin 5 voltage. So A2 sends enough base current into Q1 to make the voltage drop across R10 (1.2 ohms) equal about 0.39 volt. This is a Q1 collector current of about 325 milliamperes which heats Q1 and the enclosure it's attached to.

As the thermistor heats, its resistance goes down so there is less voltage drop across it. The A1 output voltage goes lower, so the A2 non-inverting (pin 5) input voltage goes lower. A2 supplies less base current to Q1 so its collector current goes down. Theoretically, the set-point is the temperature at which the voltages at pins 2 and 3 of amplifier A1 are equal. In practice, this is affected by the heat loss as set-point is approached. Good insulation is important.

R1 is a 5% resistor, but both R2 and R3 are one percenters. Also, I could see that R2 and R3 were hand-soldered to the foil side of the board. Commercial thermistors often have a 10% resistance tolerance so either you have to use a trimmer pot or hand-pick a resistor or two to get the desired set-point temperature.

In the second circuit type, the thermistor's resistance change varies an oscillator's pulse width. This duty-cycle change produces a corresponding change in the average heater power. You may argue that this approach is less sensitive to DC drift than direct DC control. This is probably true, but well-designed circuits of both types perform well in commercial use.

In either type, the heating element can be one or more power transistors thermally connected to the enclosure to be controlled. The sensing thermistor can be epoxied or otherwise attached (mechanically and thermally) to the enclosure near the heater. An example of this construction is shown in the Figure 6 photo.

Sometimes the thermistor is merely placed on the controller PC board along with the other components. Then the board is placed inside the controlled enclosure. In this case, the thermistor is sensing the air temperature instead of the enclosure temperature. Although there may be a thermal gradient in the enclosure's air space, a stable temperature at the thermistor should indicate a stable temperature at the crystal or other critical

RESOURCES

ANSI-MC96.1-1982, Thermocouple temperature/EMF tables
American National Standards Institute
1430 Broadway, New York, NY 10018
(Portions of the tables are also reprinted in temperature sensor catalogs.)

Analog Devices, Inc.
1 Technology Way
Norwood, MA 02062-9106; 800-262-5643 or on-line at www.analog.com

Circuit Cellar INK Magazine
4 Park Street, Suite 20, Vernon, CT 06066
860-875-2199 or on-line at www.circuitcellar.com

Dallas Semiconductor
4401 S. Beltwood Parkway
Dallas, TX 75244; 972-371-4448 or on the web at www.dalsemi.com

Mechanical thermostats
Elmwood Sensors
500 Narragansett Park Drive
Pawtucket, RI 02861; 800-356-9663
www.elmwoodsensors.com

Thermistors
Fenwal Electronics, Inc.
450 Fortune Boulevard
Milford, MA 01757-1745; 508-478-6000
www.fenwall.com

YSI, Inc.
P.O. Box 279, Yellow Springs, OH 45387
800-747-5367, www.ysi.com

Platinum resistance sensors
Minco Products, Inc.
7300 Commerce Lane
Minneapolis, MN 55432-3177
612-571-3121 or www.minco.com

National Semiconductor
2900 Semiconductor Drive
Santa Clara, CA 95052-8090
800-272-9959 or www.national.com

Omega Bond thermally conductive epoxy
Omega Engineering
1 Omega Drive, Stamford, CT 06907
800-826-6342 or www.omega.com

component. However, there can be a problem with using still air to thermally couple the sensor and heater. The thermal time constant will be 10s of seconds, perhaps even 100 seconds. At the very least, this means it will take a long time for the enclosure to settle to its steady-state temperature. The heater will overheat the enclosure because the sensor response is lagging so far behind.

In general, it's best to tightly couple both the sensor and heater to the enclosure, thermally and mechanically. A metal enclosure conducts heat much faster than still air and has a higher thermal capacity (holds more heat) so close coupling will provide the best temperature control.

Flexible resistance heating pads are also available in a range of sizes. These can be attached to the inside or outside surfaces of the enclosure. Of course, the heated region is surrounded with insulation, usually rigid foam or fiberglass. This lessens the amount of heater power needed and helps stabilize the temperature.

As you can see, there are many variations on thermistor-sensed enclosures. But this clearly shows that one design is not necessarily better than the others.

PLATINUM RESISTANCE SENSORS

Small gauge platinum wire can be wound on a rod to form a small diameter cylindrical sensor or the wire can be wound on a flat form to resemble a "postage stamp" with two wire leads. The Minco Products, Inc., S32PB11 is the later type and can be cemented to the surface whose temperature is to be measured. The sensitivity or resistance change vs. temperature is very linear over the whole useful measurement range, as shown in Figure 7.

Platinum sensors are very accurate and stable and they are also rather expensive. But when you need precise measurement or control, this sensor is by far the best choice. Thin-film platinum sensors are available for applications with relaxed requirements at much lower cost. For example, the Minco Products S245PD12 has a resistance tolerance of ±0.12% at zero degrees C at a small quantity price of only $4.00. The thin-film repeatability and long-term stability are almost as good as those of their higher-priced relatives.

The National Institute of Science and Technology (NIST) used a platinum sensor to control the temperature of the inner enclosure for their standard cell groups. The temperature instability over periods of several days is less than 0.00002°C (20 microdegrees). Figure 8 shows a block diagram of this controller. So how does this circuit work?

The 400 Hz oscillator is a Wein bridge circuit with an amplitude drift of less than 0.005% so as to have negligible effect on the controlled temperature. The oscillator output drives a two-stage transformer with an electrostatic shield between the stages. A tapped auxiliary transformer provides the temperature adjustment by effectively varying the turns ratio between the two transformer stages. The transformer output is coupled to a 400 Hz bandpass filter through a platinum sensor, which is the temperature controller.

The bandpass filter reduces 60 Hz noise. The 400 Hz amplifier "block" is actually two opamps in cascade which provide 90 dB gain. This output goes to a phase-sensitive detector used as a rectifier. The DC amplifier provides the current gain to drive the heater.

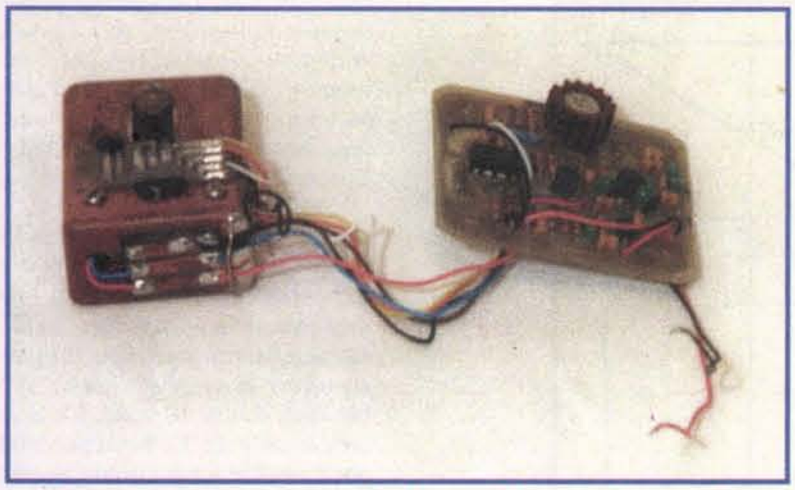


Figure 6 — Frequency control crystal oven showing the power transistor used as the heater and the temperature sensing thermistor.

Having most of the system gain at 400 Hz gives better overall stability than is possible with DC control.

ACTIVE SOLID-STATE SENSORS

Over the last several years, many active solid-state temperature sensors have been introduced. Some have digital outputs while others are analog. The Dallas Semiconductor DS1620 is an example of the digital type and lends itself to building a digital-display thermometer (for an example, see the article in *Circuit Cellar INK* for June '95, page 72).

ANALOG DEVICES TMP01

This sensor has a temperature-proportional output voltage and two user programmable temperature trip points. You can easily set an over and under-temperature logic output with three external resistors. These outputs will provide the hysteresis for an electronic thermostat, or sound an alarm, or open a relay. Of course, you also have the analog output for measurement or control.

This IC operates from a single supply voltage, 4.5 to 13 volts, and comes in an eight-pin DIP, SOIC surface mount, or TO-99 metal can. The metal can is especially easy to use because the chip die is thermally attached to the can. The DIP and SOIC aren't as convenient because the epoxy package is a rather good thermal insulator. Heat is primarily conducted to the die by the metal leads. So, if you are wanting to use this sensor to control an enclosure's temperature, how do you attach it?

You need good thermal contact to the usually metal enclosure, but you also need electrical insulation. One approach is to solder the wire leads to the needed pins (three pins for temperature control) and then embed the sensor in a "glob" of thermally-conductive epoxy (such as Omega Bond OB-101) on the enclosure. This holds true for other eight-pin epoxy packages that need to be in good thermal contact with a surface.

The TMP01 can be used between -55 and +125°C with a typical accuracy of ±0.5°C over this range. Its analog output voltage (VPTAT) is five millivolts per (degree) Kelvin which equals 5 mV x (degrees C + 273), or about 1.49 volts at +25°C. Five millivolts per degree is a good signal level for short distances to the measurement or control circuit, but as the distance increases, resistance loss in the wire and noise pickup can degrade accuracy. Figure 9 shows a simple way to preserve low-error performance with a voltage-to-frequency converter. At the other end, the original analog voltage can be recovered with a frequency-to-voltage converter.

Analog Devices has a data sheet and design program for Microsoft Windows which will give you the details on choosing the external programming resistors. Free on request.

ANALOG DEVICES TMP03

This three-terminal sensor has a serial digital output which consists of a squarewave with a variable duty cycle. This is illustrated in Figure 10. You can use a counter or microprocessor to measure the T2 time interval which is proportional to the temperature. A single-wire interface is about as simple as it gets!

This sensor will operate from 4.5 to 7 volts and supply current is just 1.3 milliamperes maximum at five volts. The TMP03 comes in three epoxy packages: a TO-92, an eight-pin SOIC, and TSSOP surface mount. In the eight-pin units, five pins are unused.

The TMP03 has an accuracy of ±4°C maximum over its -25 to +100°C operating range so it's basically less accurate than the TMP01. However, its simple digital interface may compensate for its lower accuracy. This article isn't meant to be a comprehensive survey of ALL active temperature sensors. For any measurement or control problem, get data sheets on every one you can find and compare the specs.

NATIONAL SEMICONDUCTOR LM34, LM35, and LM45

These are all three-terminal sensors with an analog output voltage proportional to tempera-

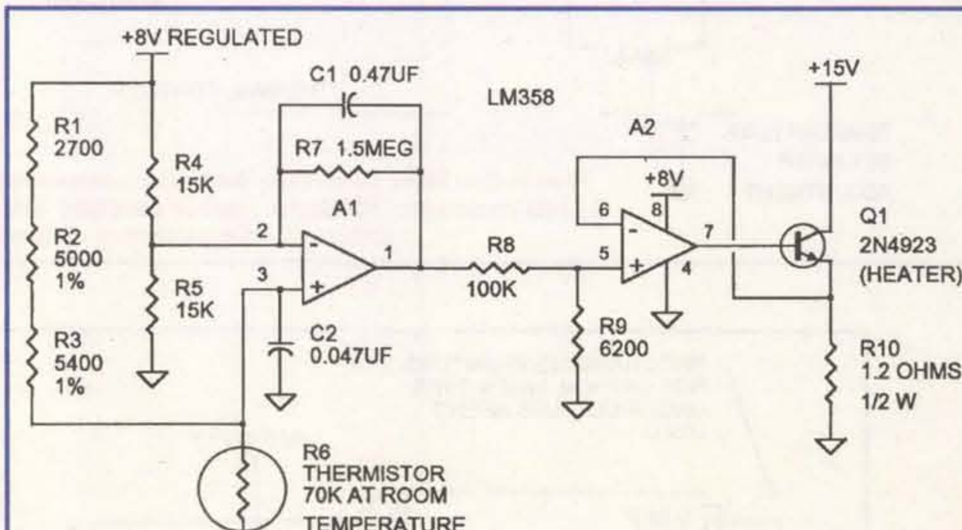


Figure 5 — Crystal oscillator heater circuit using proportional DC control. Thermistor is in thermal contact with the heated enclosure.

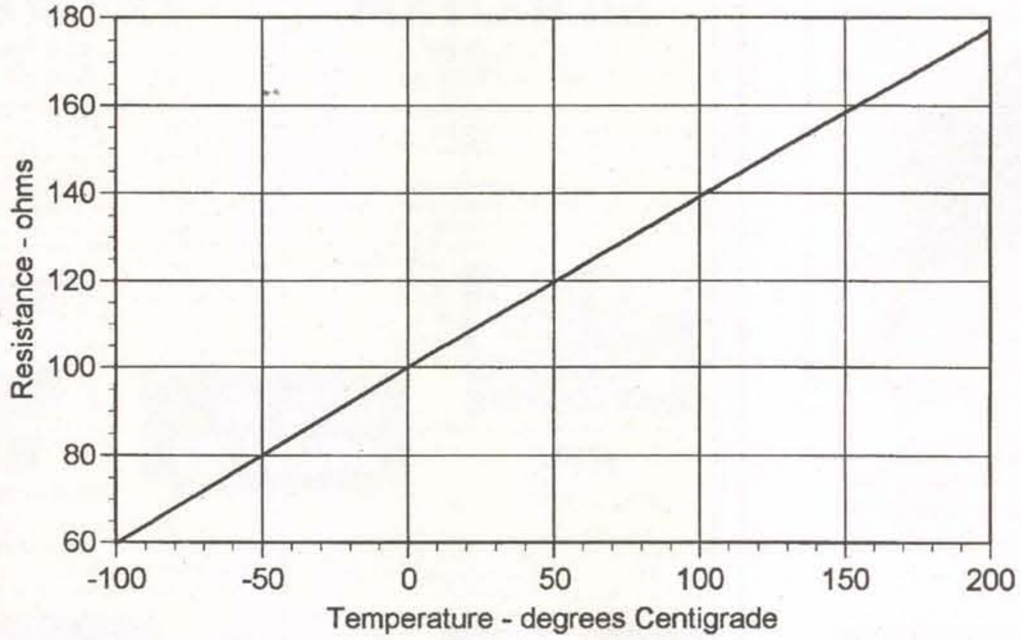


Figure 7 — Typical platinum resistance thermometer resistance-temperature curve (Minco Products type S32PB11). These sensors have excellent accuracy and stability.

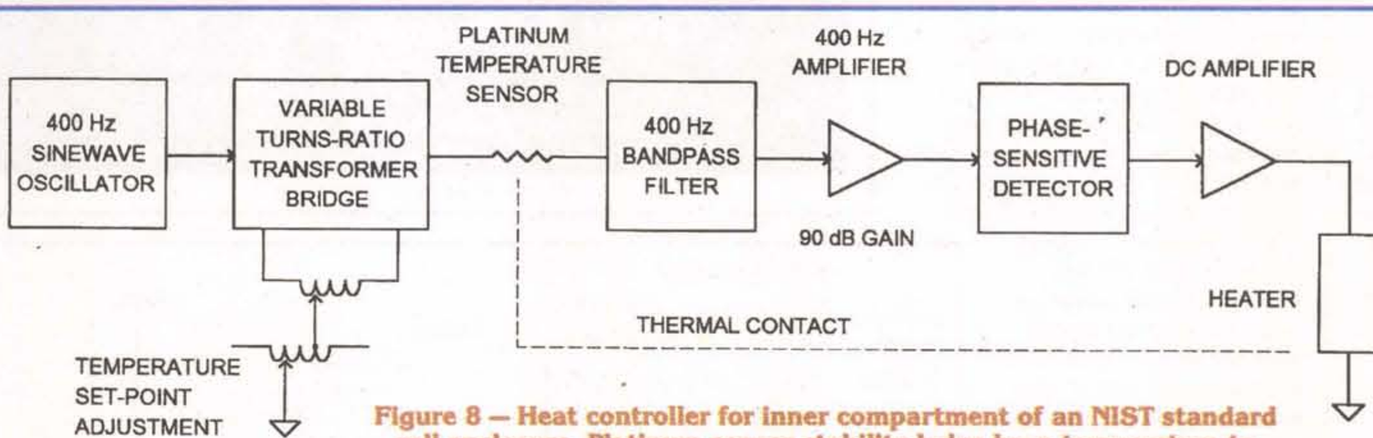


Figure 8 — Heat controller for inner compartment of an NIST standard cell enclosure. Platinum sensor stability helps keep temperature to within 20 microdegrees of the set-point.

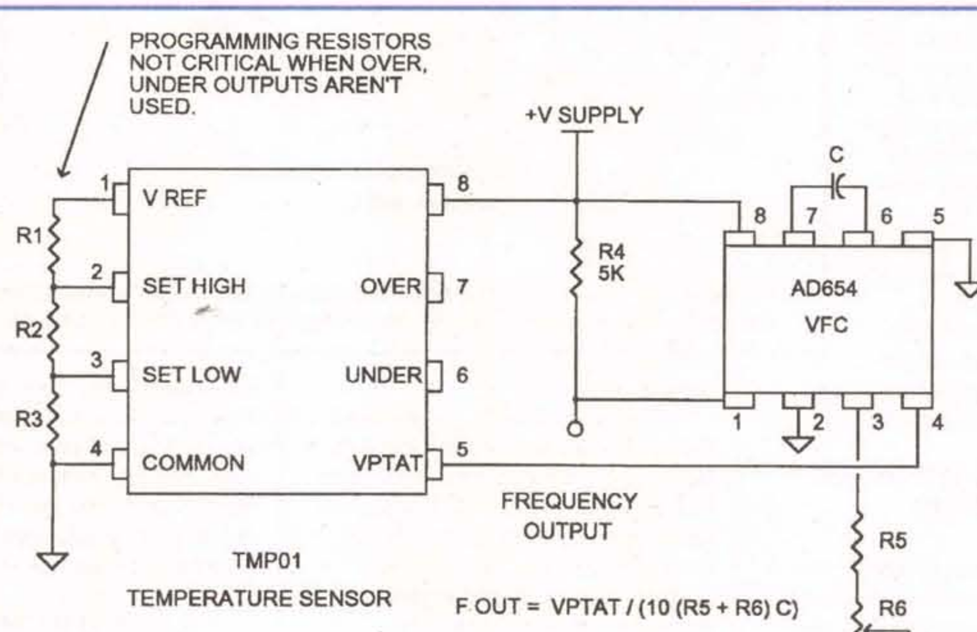


Figure 9 — Temperature to frequency converter. Another type of VFC can be substituted for the AD654.

ture. The LM34 is calibrated in degrees Fahrenheit, and the LM35 in degrees Celsius. Both of these come in TO-46, TO-92, and surface mount SO-8 packages and they can be ordered from Digi-Key Corporation (see Resources list).

The LM45 is calibrated in degrees Celsius, has an output of 10 millivolts per degree over a temperature range of -20 to +100, and comes in a teeny-tiny SOT-23 surface mount package. It operates from a supply voltage between 4 and 10 volts. It's accuracy is only ±3°C, but it seemed a good choice for a control application since stability is often more important than the actual temperature. The 10 mV per degree is a good, hefty signal to work with. Besides, I had a couple of free samples.

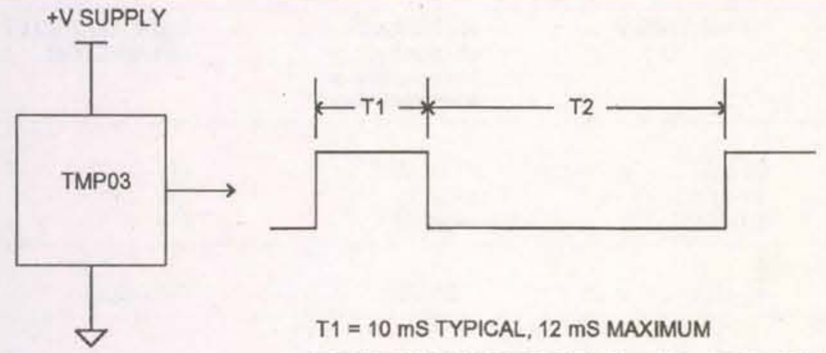
Earlier I mentioned that another type of controller used a variable pulse duty cycle to control the average heater power. I needed this type controller in a particular application because the circuit becomes battery operated during power outages. On-off control of the amplifier that supplies the heater current is very efficient. This circuit is diagrammed in Figure 11. Let's take a look at how it works.

IC1 is connected as a low frequency oscillator (about 3 Hz) with a sawtooth output taken from pin 2. Q1 and its associated resistors (R1, R2, and R3) supply a constant current which makes the sawtooth ramp-up more linear than just using a single resistor. The sawtooth is applied to the non-inverting IC3 input.

The amplified sensor voltage goes to the inverting input. IC3's output goes high whenever the sawtooth voltage equals or exceeds the sensor voltage at the inverting input. The result is a pulse whose width is proportional to the sensor temperature.

When the circuit is first turned on, the sensor is at room temperature and the sawtooth voltage is always higher than the sensor voltage. IC3's output stays high and maximum heater current flows through Q2. As the sensor heats, its output voltage goes up and the circuit goes into pulse mode. The dissipation in Q2 is very low because it is either on or off, and the power MOSFET has a very low on resistance.

The heater, shown as the flat rectangle in the Figure 12 photo, is a flexible stick-on unit with a resistance of about 55 ohms so maximum heater power is a low four watts. Heat up time is a very



T1 = 10 mS TYPICAL, 12 mS MAXIMUM
TEMPERATURE (DEGREES C) = 235 - ((400 x T1) / T2)
IF T1 AND T2 ARE MEASURED WITH THE SAME CLOCK, SMALL DRIFTS ARE CANCELLED BY THE MATHMATICAL DIVISION.

Figure 10 — Analog Devices TMP03 temperature sensor serial output timing.

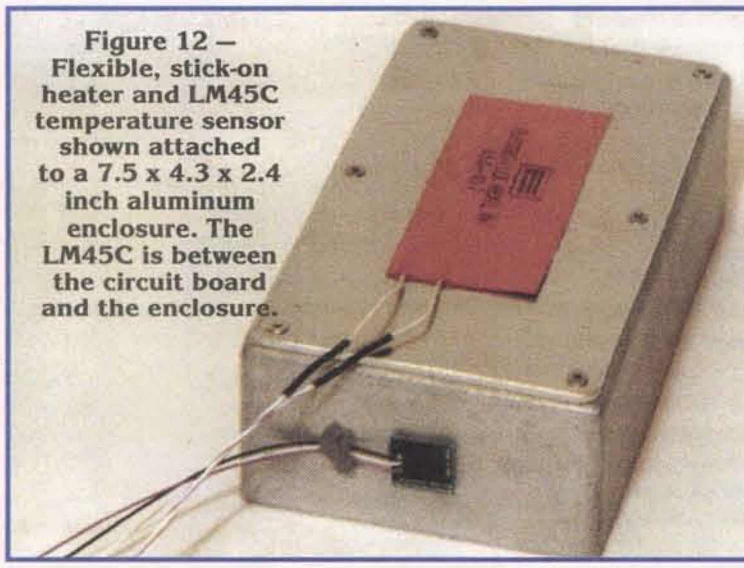


Figure 12 — Flexible, stick-on heater and LM45C temperature sensor shown attached to a 7.5 x 4.3 x 2.4 inch aluminum enclosure. The LM45C is between the circuit board and the enclosure.

long several hours, but this circuit is intended to be on all the time so low power consumption seemed more important. The power decreases to about 1.2 watts at the set-point temperature in a box with three inches of rigid foam insulation on all sides. Temperature stability after warm up is a "straight line" at my measurement resolution of 0.05°C.

The LM45C is soldered to a small PC board along with its three wire leads. Then I stuck it to one end of the aluminum enclosure, sensor towards the enclosure, with a bit of Bondo Plastic Metal (see photo). This stuff seems to work, as well as thermally conductive epoxy and it's available at your corner hardware store.

Set-point temperature is determined by the gain of amplifier IC2 and it's set by varying the resistance of R4, as shown in Figure 13.

Constant temperature control systems that are left on all the time should have an over temperature monitor. This can be as complex as using an LM75, which we'll be looking at next, or as simple as a mechanical thermostat which opens at a temperature 5 to 10 degrees higher than the set-point. A variety of thermostats can be found in the Elmwood Sensors catalog. Ask for a copy.

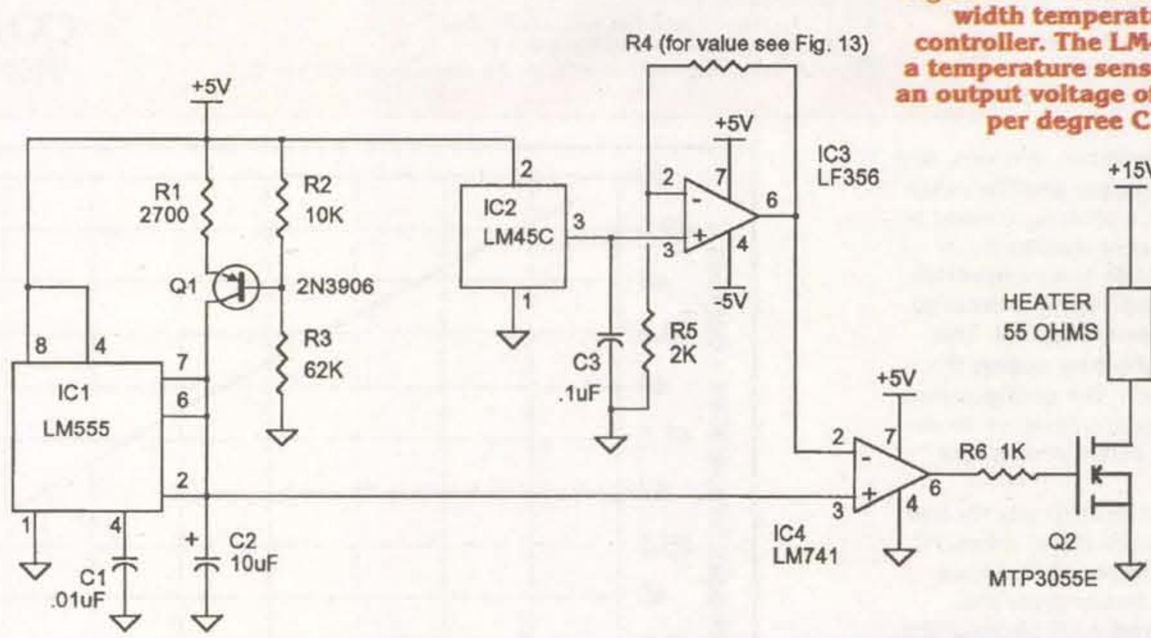


Figure 11 — Variable pulse width temperature controller. The LM45C is a temperature sensor with an output voltage of 10 mV per degree C.

NATIONAL SEMICONDUCTOR LM75

The LM75 is a temperature monitor, analog-to-digital converter, and digital over-temperature detector with a serial interface, all in a tiny eight-pin SO-8 surface mount package.

This sensor has a three line address input, so up to eight units can share an address bus. The host computer or microprocessor can program the over-temperature set-point and read out the temperature at any time over the serial interface. The temperature data

format is a nine-bit, two's complement word with the least significant bit equal to 0.5°C.

The LM75 can be used as an over temperature protector by programming a host microprocessor to monitor the temperature and then sound an alarm — play "Dixie," light a lamp, or just open a relay to disconnect heater power if the limit is exceeded. Default over-temperature is set to 80°C on power-up, so this sensor can be used as a stand-alone thermostat at this setting. An independent over-temperature output is provided at pin 3.

SENSOR TYPE	USEFUL TEMPERATURE RANGE	SENSITIVITY	ACCURACY (Actually, inaccuracy or uncertainty)	REPEATABILITY (STABILITY)
Thermocouples				
Chromel-Constantan (type E)	-270 to 400°C	60 uV/°C	±1 to ±5°C	[1]
Chromel-Alumel (type K)	-270 to 1400°C	40 uV/°C	±1 to ±5°C	[1]
Copper-Constantan (type T)	-270 to 1400°C	40 uV/°C	±1 to ±5°C	[1]
Thermistors				
Fenwal 121-102EAJ (glass bead)	-100 to 300°C	40 ohms/°C at 25°C	0.25°C[2]	0.25°C[3]
Platinum Resistors				
Minco S245PD (thin film)	-70 to 400°C	0.4 ohm/°C	0.3°C	0.1°C
Minco S32PB	-62 to 220°C	0.4 ohm/°C	0.1°C	0.1°C
Reference thermometer	-180 to 500°C	0.4 ohm/°C	±0.025°C	0.0025°C/year
Active Solid-State Sensors				
AD TMP01	-55 to 125°C	5 mV/°C	±1.5°C max	0.25°C typical
AD TMP03	-25 to 100°C	0.12 mS/°C	±4°C max	0.5°C typical
NS LM45C	-20 to 100°C	10 mV/°C	±3°C max	0.12°C typical
NS LM75	-25 to 100°C	0.5°C[4]	±2°C max	0.5°C typical

Notes: [1] depends on environment
[2] 1% tolerance probe or with calibration
[3] if used at less than 100 degrees C
[4] 9-bit word with least significant bit equal to 0.5 degree C

COMPARISON TABLE
TEMPERATURE SENSORS

Available in two versions, one for five-volt supply and the other for 3.3 volts, operating current is one milliampere maximum. A shutdown mode is also available which reduces supply current to one microampere typical. This mode is enabled by setting the shutdown bit in the configuration register. Over-temperature monitoring stays active during shutdown.

National Semiconductor had (and maybe still does) a free PC board with Microsoft Windows software to demonstrate the LM75's operation. A photo of the LM75 demo board and smaller LM60 demo board is shown in Figure 14.

Many active, solid-state sensors aren't even touched on here, but this is a representative sample. Collect all the data sheets and catalogs you can find and compare specs. Then the next time you have a temperature measurement or control problem, the information in this article will help get you pointed in the right direction. **NV**

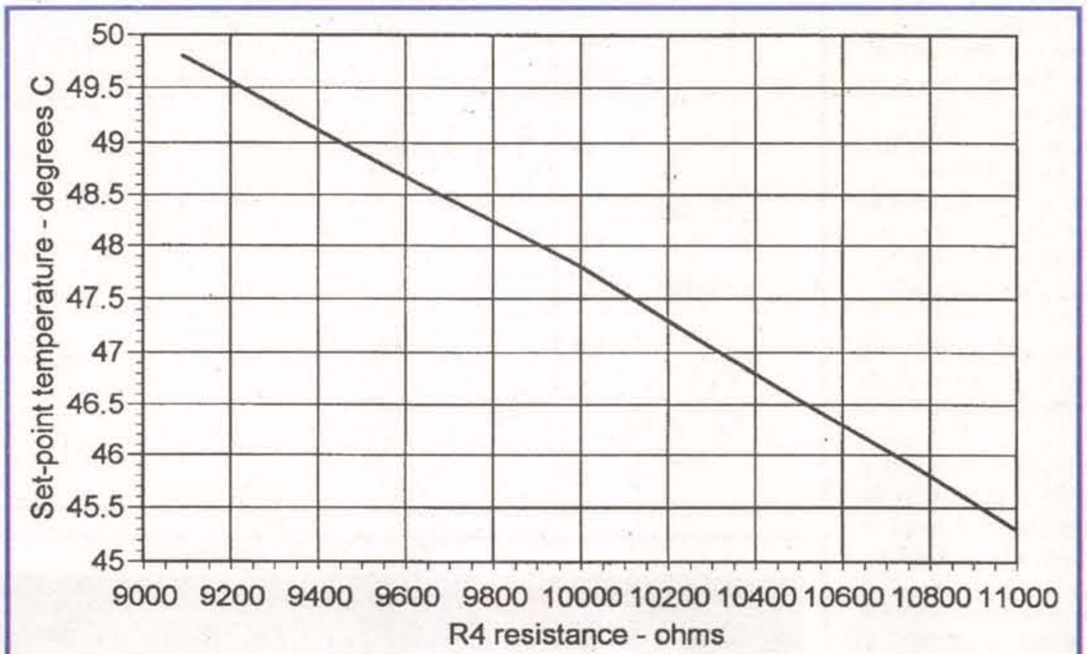


Figure 13 — Set-point temperature control in the variable duty-cycle controller using an LM45C temperature sensor.

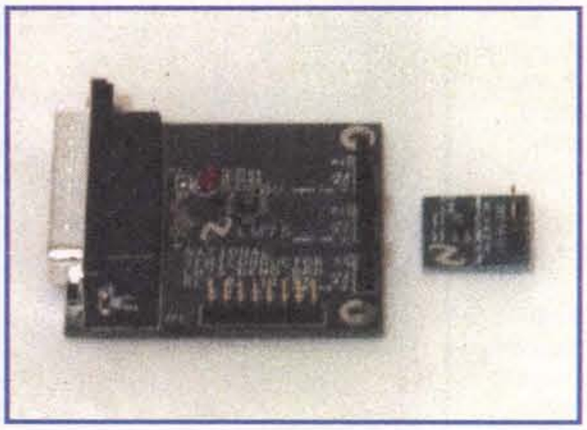


Figure 14 — National Semiconductor LM75 and LM60 (smaller) temperature sensor demo PC boards. The LM75 board has an RS-232 port for connection to a Microsoft Windows computer. Demo software is supplied with the board.

I've also collected some useful TM&C info (including the Circuit Cellar INK thermometer article) on our Web site as a "zipped" PDF (Adobe Acrobat) file. Go to www.zianet.com/tdl and click on Magazine Article Reprints. Find this article and then click tm&c.zip to download. If you don't have the free Adobe Acrobat Reader, there's a link on our home page to download a copy.

2539 W. 237th Street, Bldg. F, Torrance, CA 90505
Order desk only: **USA: (800) 872-8878 CA: (800) 223-9977**
L.A. & Technical Info: **(310) 784-5488** Fax: **(310) 784-7590**
http://www.digisys.net/timeline

TIMELINE INC.

Over 14 years and 32,000 customers and still growing

Minimum Order: $20.00. Minimum shipping and handling charge $5.00. We accept cashiers checks, MC or VISA. No personal checks or COD's. CA residents add 8.25% sales tax. We are not responsible for typographical errors. All merchandise subject to prior sale. Phone orders welcome. Foreign orders require special handling. Prices subject to change without notice. 20% restocking fee for returned orders.

LIQUID CRYSTAL DISPLAYS

240x64 dot LCD with built-in controller.

AND 4021ST-EO. *Unit is EL back-lit.* $59.00 or 2 for $109.00 *or*
OPTREX. DMF5005 *(non back-lit)* $49.00 or 2 for $89.00
20 character x 8 line 7½L x 2½H *The built-in controller allows you to do text and graphics.*

Alphanumeric—parallel interface

16x1	$6.00	20x2	$8.00	32x2	$8.00
16x1 (lg. char.)	$8.00	20x4	$8.00	40x1	$8.00
16x2	$6.00	20x4 (lg. char.)	$10.00	40x2	2 for $20.00
16x2 (lg. char.)	$10.00	24x2	$8.00	40x4	$20.00
16x4	$12.00	32x4	$10.00	4x2	$5.00

5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • ***Certain models are backlit, call for more info.***

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$20.00	480x128	Hitachi	$10.00
640x400 (backlit)	Panasonic	$15.00	256x128	Epson	$20.00
640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$10.00	240x64	Epson	$15.00
			160x128	Optrex	$15.00

6" VGA LCD 640X480, Sanyo LMDK55-22 **$19.00**

MONITORS

9" COLOR SVGA MONITOR $169.00
Fully Enclosed – Tilt and swivel type.

MONITORS

Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.

5 inch Amber $19.00 • 7 inch Amber $19.00
9 inch Amber or Green $19.00

5" COLOR MONITOR $29.00 2 for $49.00
• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible
• 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq.
• Open Frame Construction • Standard Interface Connector • Degaussing Coil included • Mfr. Samtron

HACKER CORNER

EMBEDDED 486 COMPUTER

$79.00 2 for $149.00

Complete enhanced Intel 486SX-33 based computer in ultra small (9-7/8L x 6-5/8W x 3-1/8H) case. Ideal for embedded operations or as a second computer. Features include: • One 16 bit ISA slot • 3 serial ports plus dedicated printer port • Parallel optical coupled adapter port • Built in IBM PC/AT keyboard port • On board VGA video and port • Uses standard SIMM up to 32 MB • BIOS is PC/AT compatible

Unit has a backup Ni-Cd battery system in case of power failure (5 min. backup time) and lockable front cover to prevent floppy drive access. Mounting / interface provisions for standard 3.5" laptop floppy and 2.5 inch hard drives. Comes with very comprehensive manual.

NTSC COMPOSITE
4" LCD MONITOR $69.00

ROCKWELL™ "JUPITER" GPS RECEIVER $69.00

Miniature (2.75" x 1.5" x .25") 12 channel receiver engine • Supports NMEA 0183 and binary protocols • Supports DGPS input in both protocols • Compatible with active and passive antennas • "Keep-Alive" reduced power capability • Standard 2mm 2x10 interface connector • Complete manual and interface documentation available • Compatible with most laptop software using NMEA interface • Suitable for wide range of GPS applications including: Handheld GPS, Automotive / Marine / Aviation Applications, Amateur APRS and Packet.

SONY Miniature Color LCD Display (LCX005BKB) $29.00
• 1.4 CM (0.55 inch) Diagonal Full Color Display • Built In Horizontal and Vertical Drivers • Delta Dot Pattern for High Picture Quality - 537 dots (H) x 222 dots (V) • Compatible with NTSC & PAL Format and Sync Inputs • 12 VDC Operation with -1 to +17 V RGB Signal and Driver Input Voltage • Excellent Display for Virtual Reality Projects, Viewfinders, and Miniature Test Equipment Displays • Pin Outs and Specification Included • Unit Requires Clock, Synchronization and Video

1.8cm (0.7 inch) unit LCX009AKB 827H x 228V **$29.00**

CELL SITE TRANSCEIVER $29.00 2 for $49.00

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Write in 37 on Reader Service Card.

Continued from page 42

FREE FLYER on DBS files, hacking, hardware info. Smart card socket $5 ea. New Atmel 89C52 $10 ea. Bill 1-800-879-9657.

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

MILITARY SURPLUS ELECTRONICS

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

AUDIO — VIDEO — LASERS

BROADCAST VIDEO equipment wanted: all types, new or old. Please call, Jon with info. 1-800-539-2859.

WANTED: PRO video equipment, VCRs, switchers, cameras, etc. Advanced Media 702-874-1911.

ANTIQUE VIDEO TRANSFER SERVICE: transfer any 2" QUADRUPLEX tape. Affordable fast! Phone/fax 415-821-7500 or 415-821-3359. 5001 Diamond Heights Blvd., San Francisco, CA 94131-1621.

FREE LASER CATALOG. Helium-Neon, Argon, ruby, visible laser diode modules, lightshows, holography, laser pointers. Lowest prices. Midwest Laser Products, PO Box 262, Frankfort, IL 60423. 815-464-0085 **www.midwest-laser.com**

SYNC-A-LINK UNIVERSAL video sync generators. For more details phone 918-479-6451, E-Mail: rlc@sstelco.com or write to **Sync-A-Link**, PO Box 4, Locust Grove, OK 74352.

www.nutsvolts.com

FASTER THAN MOTOROLA

Two-way radio jamming equipment 800/900MHz. Stop illegal surveillance. **Pager jammers 900MHz.** Stop pagers from going off during school or church service. **Cellular phone jammers.** Stop cellulars from going off during school or church service. **PCS jamming, PCS phones. Lojack**/teletrack/boomerang. Stop illegal tracing/anti-surveillance. Cordless phone jammers 49MHz/900MHz • Radar jammers Xband • Nextel jammers • Car alarm jammer • CB radio jammer • Garage door jammer • RC radio jammers • AM/FM radio • HF/VHF/UHF radios • 1/8000MHz jamming equipment.

This equipment is designed for anti-surveillance customers: embassies, schools, churches, governments, law enforcement.

IF YOU DON'T SEE WHAT YOU WANT, WE WILL BUILD IT FOR YOU!!

We sell only to specific organizations or for export. Anyone implying illegal activity will be denied assistance and will be reported to law enforcement.

Jam RF • 954-561-8128 or www.jamrf.com

SX Debugger+Programmer

SX-ISD

The ultimate tool for the 100mhz SX microcontrollers - Qualified by Scenix Semiconductor

- In-system debugger for SX18/20/28/48/52
- Built in programmer
- Real-time in-system code execution
- Full speed emulation
- Real-time breakpoint
- Frequency synthesizer from 25khz to 75mhz
- Source level debugging for SASM, SXC
- Selectable internal frequencies
- External break and clock inputs
- Conditional animation break
- Software animation trace
- Parallel port interface
- IDE runs under Win 95/98/NT
- Comes with SASM Assembler, SXDEMO board, SX28AC device and 18-pin, 28-pin SDIP headers

$375

Also Available

PGM2000 Gang Programmer
- Stand alone 8 gang programmer
- Parallel Port Interface for on-line operation
- Different 8-socket program adapters to support DIP, SOIC, SSOP, TQFP, PQFP packages
- Adjustable programming voltages in 0.1V
- Codes and fuse reside securely in EEPROM of Master Control Unit
- Comes with Win 95/98/NT software
- Also supports other processors
- From $900

PGM-SX Programmer
- Parallel Port Interface
- 40-pin ZIF socket to carry device to be programed or program in-circuit
- Comes with Win 95/98/NT software
- Comes with SASM assembler
- Optional SOIC, SSOP, TQFP and PQFP programming sockets
- PGM-SX $149, SMT adapters $120

Advanced TransdAtA
CORPORATION
14330 Midway, #128, Dallas, Texas
Tel 972.980.2667 Fax 972.980.2937
Email: atc1@ix.netcom.com

www.adv-transdata.com

Write in 38 on Reader Service Card.

STEREOSCOPER VR is a stereo multiplexer that creates 3D stereoscopic video from two genlock cameras. Stereoscoper VR comes with LCS glasses and driver. 90 day warranty $247 or write to **Sync-A-Link**, PO Box 4, Locust Grove, OK 74352. Phone 918-479-6451, E-Mail: rlc@sstelco.com

CABLE TV

NEW IN BOX 860MHz analog converters. Enjoy the newest technology CATV equipment can offer along with superior quality all in one unit. Channel ouput 3 or 4. HRC, IRC, standard switchable. Includes 1 set of audio/video cables, 1 RF quick connect cable and remote control. Parental control, sleep timer, last channel recall, memory 1 thru 4, and volume control are all available on remote. Minimum order taken for 10 pcs. at $59.95 each. $49.95 for 50 pc. order. Significant savings on larger quantities. Call 706-657-4445.

POSITIVE NOTCH FILTERS. All channels available. Starting at $16 each. Order by single channel #. Top quality non-tunable metal cylinder type. 75dB deep on the notch. Need to block the video on a cable channel? Order a negative notch filter. We carry a large stock on all channels for dealers and vendors. VISA, MASTERCARD, DISCOVER, and UPS COD for established customers. Quantity pricing on 5 or more. 100 pcs. $7 each. Open 8am to 5pm CST, Monday-Friday. All sales must comply with FCC 1996 Cable Act. On the web go to **WWW.GOFILTERS.COM "THE FILTER COMPANY."** Call for all orders **1-800-235-8080**.

GENUINE UNMODIFIED JERROLD DPBB 7312. 410-485-7772. E-MAIL: CLEWIS7298@AOL.COM

Tired of Expensive Inkjet Cartridges ?

Save 90% on Inkjet Inks !

Printer (Call for Others Not Listed!)	# of Refills		Cost/Refill		Kit Price	
	Black	Color	Black	Color	Black	Color
HP 500 Series, 400, Officejet 300, 350, Fax	7	14	**4.71**	**2.85**	32.95	39.95
HP 600 Series, Officejet 500, 570, 600	7	14	**4.71**	**3.21**	32.95	44.95
HP 820C, 855C, 870C, 1000C, 1150C, Copier 120, 210	6	12	**6.67**	**3.33**	39.95	39.95
HP 720C, 722C, 712C, 880C, 890C, 895C 1120C, 1170C	6	12	**6.67**	**3.75**	39.95	44.95
Canon BJ-10, 200, 210, 240, 250 Apple SWriter 1200, 1500	14	20	**2.15**	**2.00**	29.95	39.95
Canon BJC-4000 Series, C2500, C3000, C3500, C5000	60	60	**0.50**	**0.67**	29.95	39.95
Canon BJC-6000	**14**	**8**	**2.85**	**1.67**	**39.95**	**39.95**
Canon BJC-600, 610, 620 Apple SWriter Pro	20	13	**1.50**	**3.07**	29.95	39.95
Epson Stylus Color, Color Pro, Pro XL	12	12	**2.50**	**3.33**	29.95	39.95
Epson Stylus Color II, IIs, 1500 (Black)	15	15	**2.00**	**2.66**	29.95	39.95
Epson Stylus Color 500, 200	20	17	**1.50**	**2.35**	29.95	39.95
Epson Stylus Color 400, 600, 800, 850, Photo / 440, 640	20	17	**1.50**	**2.65**	29.95	44.95
Lexmark JP 1000, 1020, 1100, ExecJet II, IIc, Medley 4C	10	17	**3.00**	**2.35**	29.95	39.95
Lexmark JetPrinter 3200, 5700, 5000, 7000, 7200,	15	17	**2.67**	**2.35**	39.95	39.95
Compaq IJ700, IJ900, Xerox XJ8C, XJ9C	15	17	**2.67**	**2.35**	39.95	39.95
Xerox Home Center 450C, XJ6C Inkjet	22	12	**1.36**	**3.33**	29.95	39.95

SAVE 30 - 50% on New Compatible Cartridges!

Printer (CALL FOR OTHERS NOT LISTED !!)	BLACK CARTRIDGE	COLOR CARTRIDGE
Canon BJC-4000 Series, C2500, C3000, C3500, C5000	$5.50	$12.95
Apple StyleWriter 2400, 2500	$5.50	$12.95
Canon BJC-600, 610, 620 Apple StyleWriter Pro	$4.95 (9cc)	$4.95 @ (9cc)
Hi-Capacity Canon BJC-600, 610, 620	**$5.95 (15cc)**	**$5.95 @ (12cc)**
Canon BJC-70, BJC-80	$9.95 (3-pak)	$14.95 (3-pak)
Epson Stylus Color, Color Pro, Pro XL NEW PRICING	**$10.95**	**$16.95**
Epson Stylus Color II, IIs, 200	**$11.95**	**$16.95**
Epson Stylus Color 400, 500, 600, 800, 850,1520, Photo	**$11.95**	**$16.95**
Epson Stylus Color 440, 640, 660, 740, 900	**$11.95**	**$16.95**
Epson Stylus Color Photo 750, 1200	**$11.95**	**$17.95**

- **BULK Inks, Refill Accessories**
- **Glossy card stock & Coated Paper**
- **School & Government PO's Welcome**
- **2 - 3 Day Shipping**

Quality Inks for:
HP • Epson • Lexmark
Canon • Apple • DEC

Inkjet Southwest

Call or see us online!

Monday - Friday
7:30 - 4:30 PST 10:30 - 7:30 EST

www.inkjetsw.com **1-800-447-3469**

(480) 668-1069 Fax (480) 668-0959

WANTED: GENUINE RAW UNMODIFIED CABLE TV CONVERTERS. TOP CASH PAID. CALL 708-715-6118.

NEW! CABLE converter electronic service equipment and supplies for most cable converter boxes. Highest service, lowest prices. Call Ken Erny Electronics. 24 hr. order and information hot line 516-389-3536.

NOTCH FILTERS 110, 108.5, 106.5, 97.5 75dB deep notch. $19.95 ea., 1-5 qty. $15.95 ea., 6-10 qty. $11.95 ea., 11-20 qty. $9.95 ea., 21 or more qty. Call 24 hr. order and information hot line 516-389-3536.

DREAMCAST MOD chips, 6 wire model, $38 each. Complete color instructions. Also Playstation mod chips. New "Auto Dino" mode program. Works with all models up to 900X. Color instructions. Seven wire hook-up, $5 each. 10% discount for 10 or more, mix and match kits. Kits do not come with wires. Call 703-764-5118 to place an order.

PICS, GALS READ if you've lost your masters. Programming service available. Call for info. Network Sales, 616-683-0500.

GENUINE UNMODIFIED JERROLD DPBB7312 FOR SALE 10 LOT MIN. CALL 708-715-6118.

NEW IN BOX 860MHz analog converters. Enjoy the newest technology CATV equipment can offer along with superior quality all in one unit. Channel ouput 3 or 4. HRC, IRC, standard switchable. Includes 1 set of audio/video cables, 1 RF quick connect cable and remote control. Parental control, sleep timer, last channel recall, memory 1 thru 4, and volume control are all available on remote. Minimum order taken for 10 pcs. at $59.95 each. $49.95 for 50 pc. order. Significant savings on larger quantities. Call 706-657-4445.

UNMODIFIED JERROLD DPV-5 CONVERTERS, $25 ea. 10 lot min. Call 651-426-4435.

CABLE CONVERTERS. Original equipment with remote. Like new. Lowest prices. Guaranteed, ready to go. Limited models. Call for flyer 412-833-0773.

TOCOM UNMODIFIED 5503 cable converters, untouched, $6 ea. 10 lot min. Call 706-657-4445.

BRAND NEW basic converters, 550MHz w/remote, $19.95 ea. 10 lot min. Call 706-657-4445.

UNMODIFIED CABLE converters. SA 8590, $39.95 ea. 10 lot min. Call 706-657-4445.

ZENITH UNMODIFIED converters. ST 1000-288, $16 ea. 10 lot min., ST 1086, $25 ea. 10 lot min., ST 1600, $59.95 ea. 10 lot min. Call 706-657-4445.

SA UNMODIFIED cable converters. 8550 @ $9.95 ea., 8570s @ $19.95 ea. 10 lot min. Call 706-657-4445.

CABLE PARTS & EVERYTHING. Best prices & quantity discounts. WE DON'T SELL BOXES. 1-800-MODULE-0.

SONY PLAYSTATION MODCHIPS. Allows playing of CDR backups & imports. $10 + $3 shipping. 619-590-9320.

CABLE PARTS for all makes and models, raw boxes at low prices. Call 1-888-817-8100 www.chipplace.com

CABLE PARTS! Computer parts. Call for great prices or visit us on the Web: HTTP://WWW.CB-Electronics.com or call 1-800-436-8630.

THE WIZARD SAYS check out our prices. Cable parts and huge sale on raw boxes. 1-888-79-CHIPS. www.chipwizards.com

Write in 39 on Reader Service Card.

UNMODIFIED CABLE CONVERTERS. Zenith ST1600, ST1086, ST300, Panasonic 175, 145 vol. & non-vol. Regal RR-92 & RC 83, DP5, DP7, DRZ, 5503 VIP, SA 8580. Guaranteed low prices. Please call for more converters 405-631-1856.

CABLE TV. Unmodified converters DP5 $35; DPBB7 $80; 8500 series $15, etc., good prices over 100 pcs. Minimum 10 pcs. any qty., plus all major brands available. Lowest price new/refurbished/field pulls. Phone: 1-800-929-1549.

THE EASIEST way to recover your lost master code. 16C5X, 16C62X, PALs, GALs, other microcontrollers, custom ASICs. Check out our web page at www.acdinc.com for details or call 703-764-5361 or write: Advanced Circuit Designs, Inc., 5765-F Burke Centre Parkway #317, Burke, VA 22015.

DISCOUNT CABLE converters, bullet snoopers, all makes and models: Genuine unmodified General Instrument, Jerrold, Tocom, Scientific Atlanta, Zenith, Pioneer, Panasonic and more. Best warranty. Free catalog 1-800-243-0962.

ATTN. DEALERS: Pio BA-6110 (raw) $59; Zenith ST-1600 (600MHz, 99 true, ch.) only $39; Zenith ST-1601 $59, minimum 10-lot. Call for free catalog, 1-800-354-7719.

CABLE BOX remotes. $3 to $4 each. Zenith tuners like new $5. Zenith power supplies $4 each. Prepaid shipping on Zenith parts only. Repair work on ST 1000 to ST 1086 available. 702-737-4727.

TELEPHONE/FAX

PHONE SYSTEMS WANTED!!! We buy AT&T MERLIN, SYSTEM 25/75/85 and other AT&T phone systems. Please call for a quote or fax us your equipment list. **KEYWAYS, INC.**, 937-847-2300 or FAX 937-847-2350.

COMPONENTS

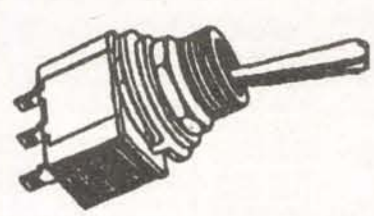
RF TRANSISTORS, TUBES, SD1446, MRF455, MRF454, 2SC2290, 2SC1969, 2SC2166, 2SB754, TA7222AP, 2SC1947, TIP42C, KIA7217, MRF422, MRF448, MRF247, MRF317, SAV7, SAV17, 3-500ZG, 4CX250B, 572B, 3CX400A7/8874, 3CX3000A7, 4CX400A, silver mica caps, resistors, electrolytics, etc. Westgate 1-800-213-4563.

FOR SALE semiconductors: Semiconductors assorted all new, no pullouts, assorted chips, 6233 semis of every kind, all are bagged and marked. Many ones or twos not over 20 of a kind, some gold plate, some mill spec. I am closing my shop after 50 years and will sell to the highest bidder. Fax me for a list and information, 201-385-5555 ask for Ange.

ICs FOR EXPERIMENTERS: Elm offers a variety of ICs for home security, infrared, Control L, as well as basic timing, switch debouncing, etc. Secure purchasing on the web at **www.elmelectronics.com**

WANT TO Buy: ICs, military & aircraft relays, diodes, transistors, Cannon, TRW, Amp, Burndy, Deutsch, Bendix connectors, electronic test equipment & most components. Hoffy Electronic Ent., 818-718-1165, FAX 818-341-5506. E-Mail: Hoffie1165@aol.com

MATCO WILL design, engineer, and develop a 2.4GHz wireless 8 channel solution for your remote applications. FCC approved. Matco, Inc., Schaumburg, IL 1-800-719-9605. E-Mail: nsales@mat-co.com Web site www.mat-co.com



AMAZING! 35¢ TOGGLE SWITCHES. Brand new. Rated 6Amp/125V. Hardware included. 1/4" panel hole. SPDT or DPDT, on-on or on-off-on. Minimum 100pcs./package. Visa or MC, no COD. Gateway Products Corporation, 1-800-830-9195. E-Mail: GtwyPrds@aol.com

SEE OUR ad on 4-channel 2.4GHz wireless systems in the AdMart section on page 70. Matco, Inc.

CASH PAID FOR ICs. Military or commercial integrated circuits, transistors, diodes, any semiconductors. **ELECTRONIC SURPLUS, INC.**, 5363 Broadway, Cleveland, OH 44127. 216-441-8500 or fax 216-441-8503, since 1946. www.electronicsurplus.com

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

MICROCONTROLLERS

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

ATMEL 89CXXXX programmer, IBM parallel port, C++ source code, schematics, $250 + S/H. E-Mail: cbanni3061@aol.com

SKINNY MINI MOTOR

$1.95

Originally designed for vibrating pagers, this 1.5VDC motor measures only about 0.6" in length, and 0.25" diameter! (The shaft is just 0.2" long, and 0.031" dia.) Features a removable counter weight, and can be easily extracted from its protective sheath. Great for all kinds of hobby applications.

120V AC - 7.5KV DC IONIZER $6.95

Originally designed as an ion air generator, this unit is ideal for experiments. 120VAC 60 cycle input, 7500VDC output. Can be used for all kinds of high voltage projects.

Spinney The Wind-Up Critter $8.50

Wind up this little guy and watch him go! Spinney shakes, bounces, and buzzes around on four wire legs. Classic mechanical wind-up workings are visible as Spinney amuses onlookers. Get creative, design your own outer casing for the Spinney to create your own wind-up creature! Great conversation piece, fun gift for anyone mechanically inclined.

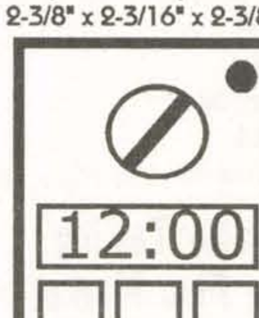
Controlling The World With Your PC...

Here's a useful book that tells you how to connect your personal computer to the real world and make it do useful work like controlling stepping motors, monitoring fluid levels, or switching appliances on and off. No PC modification necessary for these projects either -- every circuit in this book connects directly to the parallel printer port of your PC! Also included are a circuit diagram and listings for control software written in Pascal, C, and BASIC. AND (this is the good part) the accompanying disk contains full source code in all languages plus compiled (.EXE) files -- (that means no typing ... yeah!) Whether you want to generate audio tones and speech, drive high power loads and DC relays, or convert DTMF tones to binary values, this book is a great source for information, projects, and ideas. There are also 9 appendices (that's plural for appendix - that hunk of helpful info that didn't fit into any one chapter of the book!) They cover such topics as expanding the parallel port for 24 bit I/O, bidirectional printer port use, and using your PC's game port for input. Controlling The World with Your PC is $35.00

110V TIMER WITH CLOCK

$6.95

Digital LED clock display can be programmed to activate at a specified time (hours, minutes, am/pm). Ideal for turning things on while you are sleeping, so you can turn them off when you wake up! Features 3 position (off/on/auto) rotary switch. Aprrox. size 2-3/8" x 2-3/16" x 2-3/8"



SOFT-SIDE ZIPPER TOOL CASE

$3.95

This soft-sided padded black zipper case features 7 elastic loops for securing your tools, and a convenient handle for easy transport. Case measures approximately 10"x7"x4", large enough to hold most multimeters, as well as an assortment of your other tools and supplies. Great storage solution for tools in your trunk or under your car seat.

Special note for Ham Operators -- we've got the two-pin spade connectors most mobile radios use! $2.95 ea.

SPECTRUM LED A RAINBOW OF LIGHT!

$5.95

Imagine an LED capable of producing all three primary colors in the same package! The entire spectrum, including near-white, can be created! Imagination becomes reality with this T1-3/4 multi-color LED. Here's the technology: a red chip, a green chip, and two blue chips encased in a diffused T1-3/4 package. Using various current combinations, you can produce red, orange, yellow, green, aqua, blue, violet or white light! Detailed spec sheet included. What can you do with these (beyond the obvious amaze your friends!)? Create a single indicator system, designate various controls by color, make a multi-color bargraph, make your project something out of the ordinary with multicolor LEDs!

www.gatewayelex.com

Gateway ELECTRONICS, INC

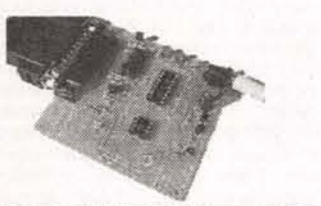
8123 PAGE BLVD * ST. LOUIS, MO 63130 * **(314)427-6116**
9222 CHESAPEAKE DR. * SAN DIEGO, CA 92123 * **(858)279-6802**
2525 FEDERAL BLVD. * DENVER, CO 80211 * **(303)458-5444**
MAIL ORDERS CALL TOLL-FREE 1-800-669-5810
FAX ORDERS (314)427-3147

nv0300

THE FINE PRINT : PRICES SUBJECT TO CHANGE WITHOUT NOTICE * GATEWAY IS NOT RESPONSIBLE FOR PRINTING ERRORS * MASTERCARD, VISA AND DISCOVER ACCEPTED * YES, WE'LL TAKE YOUR CHECK -- SORRY, NO C.O.D.s * $10 MERCHANDISE MINIMUM ON MAIL ORDERS * SUPPLY OF SOME ITEMS IS LIMITED * PRICES DO NOT INCLUDE SHIPPING * UPS GROUND SHIPPING/HANDLING WITHIN THE CONTINENTAL U.S. (ITEMS REQUIRING ADDITIONAL AMOUNTS ARE NOTED)...$5.00 FOR THE FIRST ITEM, $0.50 FOR EACH ADDITIONAL ITEM. RESTOCKING CHARGE MAY BE ASSESSED ON RETURNED ITEMS. * Why is the alphabet in that order? Is it because of that song?

DISCOVER VISA

Write in 41 on Reader Service Card.



PIC MICROCONTROLLER PROGRAMMER KIT. Super value at $19.95 + $4.95 shipping. See our web site for the complete range of PICs that can be programmed. Includes PCB, parts and instructions. P16PRO shareware must be downloaded from the web. Amazon Electronics, tel 1-888-549-3749. Lots of other products. **www.electronics123.com**

ANTIQUE ELECTRONICS

WESTERN ELECTRIC wanted: 1920s-1960s. Amplifiers, mixers, pre-amps, speakers, tubes, etc. FREE OFFER 1-800-251-5454.

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

WANTED: FOR historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-763-3311/540-382-2935).

WANTED: EIAJ R/R 1/2" color VTR. Excellent operating condition only, please. 415-821-3359, fax 415-821-7500.

AVIATION ELECTRONICS

BUY, SELL, trade, avionics equipment, Collins, King, Sperry: test equipment, IFR, Litton LTN series INUs. 941-625-3222 P, 941-625-0494 F, E-Mail: avionics@afcon.net

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

PUBLICATIONS

NEW SURVIVAL COMMUNICATIONS BOOK. How to build complete home communications systems. Covers all needs: shortwave radio, amateur radio, citizens band, scanners, federal, weather, alternate news, satellite radio, equipment sources. How to build and use alternate emergency power sources, solar, generators, backup batteries. 200 pages. $24 Fast delivery Priority Mail. MC or Visa. Call Universal Electronics 1-800-241-8171.

OUT-OF-PRINT TECHNICAL BOOKS. www.johnsontechnicalbooks.com 805-525-8955. **sales@johnsontechnicalbooks.com**

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

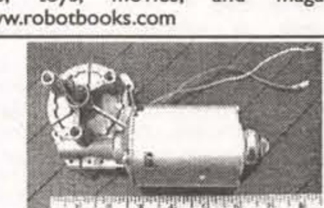
PRACTICAL ANTENNA HANDBOOK, by Joseph Carr. The most popular book on antennas ever written, widely known as "the antenna builder's bible." This *Third Edition* is a work for anyone with an interest in antennas, from the newest of novices to the most experienced engineer. This empowering book gives you all kinds of projects and material that explains why what you did works. Only $49.95! **10% discount to *Nuts & Volts* subscribers.** Call **1-800-783-4624** to order using Visa or MasterCard.

SECRETS OF RF CIRCUIT DESIGN From Joseph Carr, one of today's most respected electronics authors, comes this pragmatic, intermediate-level guide to designing, building, and testing all types of radio frequency circuits. Filled with functional projects that demonstrate the principles of RF circuits. Only $29.95! **10% discount to *Nuts & Volts* subscribers.** Call **1-800-783-4624** to order using Visa or MasterCard.

HOW TO LOWER YOUR ELECTRIC BILL and **SAVE MONEY. Learn proven methods of electricity reduction. Simply and inexpensive.** Information $2 to **LWC**, Dept. EN, 147 Halsey St., Brooklyn, NY 11216-2103.

ROBOTICS

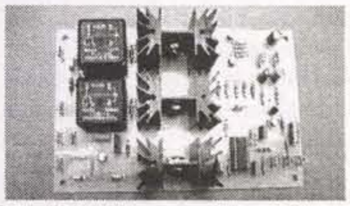
ROBOT BOOKS.COM visit our web site for reviews of robotics books, plus robot kits, toys, movies, and magazines! www.robotbooks.com



24VDC GEARHEAD motors. High torque, brand new surplus, .45A no load, 5A full load, 33 RPM, 3/8" diameter, 1" long slotted shaft with 1/8" hole, weight: 2.5 lbs., $10 each plus shipping. http://divelec.tripod.com 570-735-5053. carlk3jml@bigfoot.com

ROBOTS WANTED: Dead or alive, whole or parts. Marvin (Iowa Precision), Gemini, RoPet, Hubot, RB5X, Newton SynPet, ComroTot, ELAMI, ITSABOX, HeathKit (HERO JR, 1, 2000, or Arm Trainer), Androbots (TOPO, BOB, Fred, and Androman), Rhino, Maxx Steele, Omnibots, etc. Also looking for robot prototypes, options, and literature, will pay cash. Please E-Mail rdoerr@bizserve.com Call 810-777-1313 or write to: Robert Doerr, 26308 Cubberness, St. Clair Shores, MI 48081.

ARobot KIT from Arrick Robotics uses the BASIC Stamp II. Quality metal construction. Easy to assemble and very expandable. $235. http://www.robotics.com/arobot



30A MOTOR controllers. 12V or 24V models. PWM output. Variable speed. Stop to full forward and reverse. Approx. 3.75" x 5.75". Controllable directly from your microcontroller or potentiometer, $55 plus S&H. http://divelec.tripod.com 570-735-5053. carlk3jml@bigfoot.com

PLANS — KITS — SCHEMATICS

PCB Milling

CIRCUIT BOARDS. Low-cost, precision-made PC boards from your CAD program files (no photoplots required). Single and double-sided with contour routing. Ideal for RF/analog/digital prototypes. Full details at http://www.pcbmilling.com E-Mail: feedback@pcbmilling.com FAX: 703-818-0071.

TEST EQUIPMENT kits. If you liked Heathkit, you will love Technology Systems, 4 Prospect Pl., Torrington, CT 06790.

CONSUMERTRONICS 120+ exciting manuals: Electronics, computers, Internet, phones, energy, radionics, financial (including stocks), crime-fighting, security, survival, phenomena, **SPECIAL PROJECTS**. Catalog $3. PO Box 23097, Albuquerque, NM 87192. **www.tsc-global.com**

200+ ELECTRONIC PROJECTS. Secure WEB ordering @ www.matcopublishing.com/plans1.htm or send $1 (refundable) for catalog. MATCO-5A, POB 509, Roseville, MI 48066-0509.

SMART CARD applications CD-ROM $50. Blank smart cards $20 or 8/$100. Tony 419-385-3100.

MANUALS — SCHEMATICS WANTED

MISCELLANEOUS ELECTRONICS FOR SALE

NUCLEAR ELECTRONICS (NIM, CAMAC), PMTs, optics, high vacuum, and high voltage components and equipment. Guaranteed quality at reasonable cost. OE Technologies, Box 703, La Madera, NM 87539. Ph: 505-583-2482, Fax: 505-583-9190, E-Mail: oetech@newmexico.com http://www.oetech.com

WANTED: SERVO DRIVES. Yaskawa, Saftronics, Mitsubishi & Fanuc also misc. parts. Call: 1-800-747-7450 ask for Kurt.

SOLAR-POWERED FAN HAT. Baseball type hat with solar powered fan. Great for sports fans, golfers, etc. Available in red or blue. $19 plus $2.00 shipping. CA residents add 7.75% sales tax. Visa/MC/Disc/Amex OK. H.T. Orr Computer Supplies, 249 Juanita Way, Placentia, CA 92670. 714-528-9822, 1-800-377-2023, FAX 714-993-6216.

ANAHEIM WIRE PRODUCTS. DISTRIBUTOR OF ELECTRICAL WIRE AND CABLE since 1973. Items available from our stock: Hook up wire, Automotive primary wire, GXL, SXL, Plenum cable, Teflon wire, Multi-conductor cable, Irradiated PVC, SO-CORD, Mil-Spec wire, Building wire, Welding cable, Battery cable, Telephone wire, Shrink tubing, Cable ties, Connectors. Wire cut & strip to specs. If interested, please call **1-800-626-7540**, FAX: 714-771-5043. Visa/MC/Amex. SEE US ON THE INTERNET: http://www.anaheimwire.com OR E-Mail: info@anaheimwire.com

30KW RF GENERATOR design by Westinghouse WL6426 water cooled tube 50KW, under transmitter conditions. Mike 828-684-7672 HTTP://WWW.CHIGEOR@AOL.COM

Continued on page 80

ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist.

Feel free to participate with your questions, as well as comments and suggestions.

You can reach me at:
TJBYERS@aol.com
TJBYERS@juno.com
or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.

What's Up:

PCB chemical waste, Headphone impedence matching, Audio articles, Strobe power, Mouse adapters, Solar tracker, Modem problems, Useful websites, IC prefixes.

Safe Disposal of Waste PCB Chemicals

Q. I'm concerned about the disposal of waste printed circuit board chemicals. I've never built any projects that need an etched copper-clad board because I can't figure out where to rid myself of the expended etching chemicals. I've never seen mention of this important subject anywhere. Does the average hobbyist dump them down the toilet, bury them in the yard, or use a convenient storm drain? Most official disposal sites deal with waste oil, not hazardous chemicals.

A. The etching agent used for printed circuit boards is ferric chloride, which is not classified as a hazardous material. In fact, it's often used in water treatment plants to reduce sludge. Moreover, copper is a trace element needed by the human body and, therefore, isn't a toxic metal. And if ferric chloride weren't recognized for its etching qualities, it would probably qualify as an excellent sun-tanning ointment. In other words, contact with it turns your skin a yellow brown — something like the artificial skin-tanning creams do, and it's darn near impossible to wash off.

As to its disposal, please don't store it in a paint can or other metal container because the ferric chloride will eventually eat through the can and run amok — and worse yet, contact with an aluminum container can generate explosive hydrogen gas. Should you have a ferric chloride spill, neutralize the acid with lime (calcium hydroxide), limestone (calcium carbonate), or soda ash (sodium carbonate) — basically anything caustic. CAUTION: Limestone and soda ash will produce CO_2 gas, which, while non-explosive, can accumulate in enclosed areas. Ventilation should be provided; use an absorbent material (like a paper towel) to pick up the spill. What I do is bury it in the backyard around the hydrangeas, but flushing it down the toilet is totally acceptable in the small amounts you'll generate. For more information on ferric chloride safety, check out the chart at www.injectorall.com/MSDS%20199.htm (this table is also available on our Web site at www.nutsvolts.com under the name safeFeCl.hml).

Modem Madness

Q. This is a two part question. First, what is the best modem to use, PCI or ISA bus? A friend tells me ISA is better because of On/Off hardware flow. Second, what causes a modem to not reset? Sometimes I have to turn off the PC and restart the computer for the modem to initialize.

Joe Spinola
via Internet

A. The two parts aside, it's a tough question because it generates more questions than it does answers. First, there is no such thing as a perfect modem — just like there's no such thing as the perfect car. Each is tailored to do a specific job the best it can. For example, would you buy an 18-wheeler to take the kids to school and run errands? On the other hand, how many refrigerators can you fit in the back of a mini-van? It's the same with modems. For some users, a 33.6 kbps modem that's used for E-Mail only is more than adequate. But it won't work for a Wall Street investor, who very often has several modems connected to dedicated T1 lines. In between are the 56 kbps, ISDN, and TV cable modem links — each with its own niche in the scheme of things. So it's not a matter of which slot to plug into, but what you need in the way of communications.

The second request is a trick question, isn't it? Suppose your car won't start one morning and you call up a mechanic and simply say, "Hello, my car won't start. How come?" He'll say, "Dunno." Same answer here. What make, model, speed, provider connection, and so forth? Without this information, I can only speculate — which I'll try to do now, but don't hold me to it. If the modem won't reset, first check to see if it's let loose of the phone line — hangs up. If not, the problem is probably with the server, be it AOL software or somebody else's. If there is a dial tone and the modem won't reset, then the problem is local inside your PC. Turning off the PC simply erases all evidence of what caused the problem, allowing it to happen again. Now you know as much as I do about your situation. Good luck!

Audiophiles, Lend Me Your Ear

Q. Articles that deal with audio topics seem to be few and far between in hobby magazines, so I was wondering if you know of a magazine that deals mostly with audio? BTW, I tried the fix you gave me for my Variac and it works great!

Garry Iman
via Internet

A. There was a time when audio was a hot DIY (do it yourself) topic found in every electronics magazine and several audio/hi-fi publications. But the current state-of-the-art puts quality audio projects beyond the reach of most hobbyists, so virtually all of the articles you'll find on the subject today deal with news, equipment reviews, interviews, and company profiles. Thanks to the explosion of the Internet, though, finding good audio material has become easier and more plentiful. Here is but a handful of publications and ezines (electronic magazines) I found useful for our readers.

Bound for Sound Report
(http://www.boundforsound.com)

Publishing since 1989, Bound for Sound Report is 14 to 16 pages of concise, in-home reviews of hi-end equipment and software in all price ranges, includes mainstream and underground components. Technical articles include such topics as interconnects, line conditioning/power cables demystified; set-up advice, tweaks, and component matching.

Browse the 10-year index to read back articles; published monthly on both the Internet (free) or via first class mail ($24.00/yr.).

Hi-Fi+ (http://www.hifiplus.com)

British, bi-monthly magazine with articles, news, reviews, and previews.

Planet HiFi (http://planethifi.com)

Planet Hi-Fi, The Magazine of High Fidelity, is a free bi-monthly audio/video resource on the web. Equipment and music reviews, monthly columns, free classifieds, and the web's first Audio Doctor.

Stereophile (http://www.stereophile.com)

Inside this rather plain looking ezine (your typical assortment of reviews, industry news, and tips), you'll find access to an amazing selection of audio and video links (http://www.stereophile.com/cgi-bin/lm.cgi/ep) that had its start as Ron Rathe's "The Enthusiast's Page" a couple of years back. These links are combed and updated on a weekly basis.

UHF Magazine: Ultra High Fidelity
(450-651-5720; http://www.uhfmag.com)

Despite its lofty name, UHF Magazine is anything but pie-in-the-sky jounalism. In addition to the regular news updates, reviews, tips and interviews is a great audio doctor who is ready to answer your every audio

need. UHF Magazine has been redefining true high-fidelity since 1982.

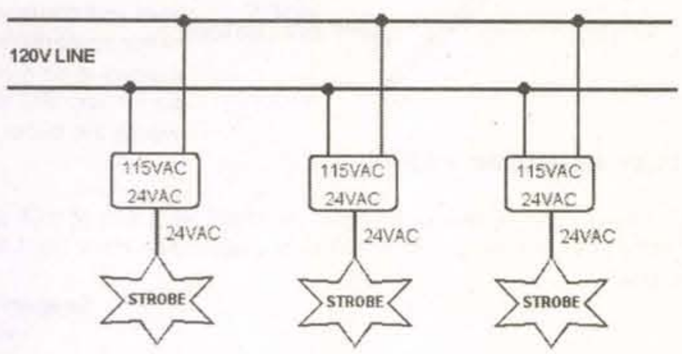
Strobe Alley Needs Power

Q. I'm looking for a 24-volt transformer to power 18 strobe lights drawing 0.85 amps each.

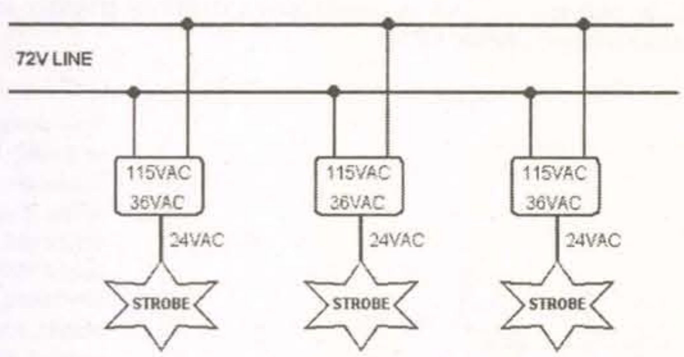
The lights will be wired in two circuits, with nine lights on each leg. The distance to the first light is 500 feet, after which each light will be 330 feet apart. I plan on running #4 AWG copper wire for 1,490 feet then switch to #6 AWG copper wire for the remainder of the run. Any help you can give me to find a supplier of this transformer would be appreciated

Robert Mitten
via Internet

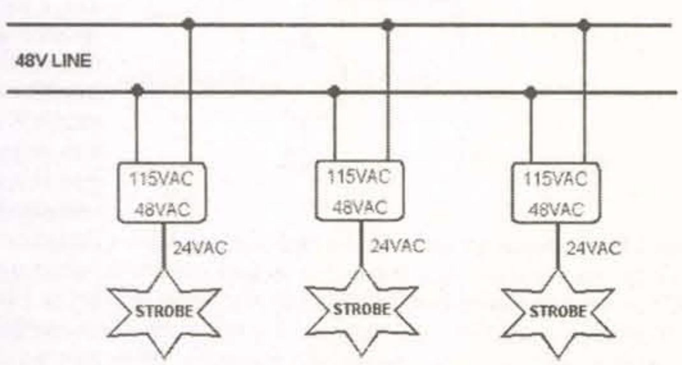
A. First of all, I wouldn't use a 24-volt distribution line for this application. Instead, I'd go with a 120 VAC line and tap the line at each strobe location using a small 24-volt, 1-amp transformer, like the Alltronics (408-943-9773; www.alltronics.com) 97N002 ($4.95) or Mouser (800-346-6873; www.mouser.com) 553-F46X ($9.26)



120V SYSTEM



72V SYSTEM



48V SYSTEM

This accomplishes three desirable goals. First and foremost, it reduces the size of the wire from 4 gauge to 14 gauge — typical house wire. Observe: The current requirement for the 24-volt system is about 8 amps per leg, and the resistance of 4-gauge wire is 0.267 ohms per 1,000 feet, which gives a voltage drop of 1.1 volts in the 500-foot section. (E = IR = 8*0.134 = 1.1 volts.) That's nearly 5 percent of the power lost in the wiring alone. The current of the 120-volt system, on the other hand, is just 2 amps per leg. With a resistance of 2.73 ohms per 1,000 feet, the voltage drop across 500 feet of 14-gauge wire is just 2.73 volts, or about 2 percent of the total power. Furthermore, you can use 14-gauge wire throughout the system, eliminating the need to mix two heavy-gauge wires. Last, but not least, 4-gauge wire costs 43 cents per foot, ($4,428.00 total with 1650 feet of #6 @ 28 cents per foot), whereas 14-gauge wire costs 5 cents per foot, ($630.00 total), for a savings of about $3,800.00. If a 120-volt system isn't practical because of building codes, the line voltage can be reduced to 72 or 48 volts, as shown in the wiring diagram above. Here are two charts showing wire resistance versus wire size, and recommended wire sizes for the three above systems.

Gauge (AWG)	Diameter (mm)	Area (cir mils)	Resistance (1000 ft.)
0	8.252	53.49	0.105
2	6.543	33.62	0.168
4	5.189	21.15	0.267
6	4.115	13.30	0.425
8	3.264	8.367	0.687
10	2.588	5.261	1.08
12	2.05	3.310	1.71
14	1.63	2.081	2.73
16	1.29	1.3088	4.35
18	1.02	0.8231	6.92
20	0.81	0.5176	10.9
22	0.64	0.3255	17.5
24	0.51	0.2047	27.7
26	0.40	0.1287	44.4
28	0.32	0.0810	70.7
30	0.25	0.0509	112
32	0.20	0.0320	176
34	0.16	0.0201	280
36	0.13	0.0127	445
38	0.10	0.0080	708
40	0.08	0.0050	1093

Recommended Wire Sizes

System Voltage	Total Amps	Amps per Leg	Voltage Drop (first 500 ft.)	Wire Size
120	3.06	1.53	2.09/2%	14
72	4.09	2.05	1.75/2.4%	12
48	7.15	3.58	1.23/2.6%	8
24	15.3	7.15	0.96/4%	4

If you insist on using the 24-volt system you describe, the transformer you want is called a furnace or power control transformer. They are available from Allied Electronics and Newark Electronics, but are very costly. You can save money by cruising the surplus electronic outlets, like All Electronics (http://www.allelectronics.com) — subject to availability, of course. (Note: Any 24-volt transformer with a 16-amp secondary or greater will work.) A better bet is to use two 8-amp, 24-volt transformers, one for each line, rather than a 16-amp behemoth. They're easier to find and cheaper.

More Mouse Adapters

Q. I read with interest your recent PS/2 to nine-pin serial adapter answer in the Dec. '99 issue, and would like to add my two cents worth. I have two mice that are both PS/2 and nine-pin serial port compatible using adapters like you described. However, neither adapter is wired like your example and, interestingly enough, neither mouse will operate with the other's adapter.

The first is a $5.00 Tandy generic (Precision Instruments) special that I use for testing. The second is a real nice Logitec Marble Ball trackball. Their wired:

Tandy Generic Adapter

PS/2	→	9-pin
1		2
2		3
3		5
4		4
5		7
6		N/C

Logitec Marble Ball Adapter

PS/2	→	9-pin
1		4
2		2
3		5
4		8
5		7
6		3

From the above, it would appear that both of these devices use additional signals to indicate to the mouse which port is being used. In one instance, Vcc is derived from DTR and in the other it's CTS. The only common denominator seems to be the ground pin. Maybe this will help someone. I suppose with proper software either adapter could be used.

Don Pomeroy
via Internet

A. Congratulations! You've just hit on the number one reason it was so hard to make early computers work properly: the lack of standards. Back in the early days there were a lot of players in the PC game, each wanting a slice of the pie. They used many ploys to get you to buy their products, but none more devious than setting their own standards. They figured that if you bought into their company and used their products, you would be forced to buy their upgrade products because it was the only part that would match

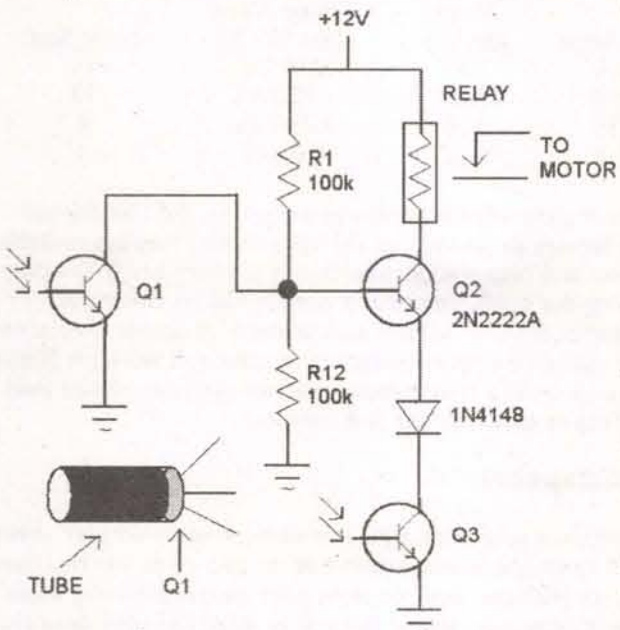
your system. The mouse is but one example. As you noticed, the adapters aren't interchangeable between the mice. Let's suppose you're using your Logitec Marble Ball and want to switch over to a mouse for one project. Well, you'd need to buy a mouse from Logitec or go through a lot of adapter swapping — with no guarantee the kluge would work properly. This is how they hoped to keep your business. Fortunately, the scheme backfired and most companies that tried it have switched to a more common standard or now RIP.

I'll Just Follow The Sun

Q. I am trying to build a small solar furnace and I thought it would be fun to make it track the sun. I'd like something that would move the oven toward the sun's position by driving two motors (servos, stepper, etc.): one for the base rotation and the other for elevation. I've surfed the web, but can only find high-end commercial products. Do you know of a simple design that won't take a rocket scientist or NASA-like budget to build?

Craig Kessler
via Internet

A. Over the years, I've built and/or tested many different kinds of sun trackers, each with its own merits — and price. Here's one I designed myself that's very reliable and inexpensive. It uses but a handful of electronic components and a single, garden-variety motor. The brains of the design is a pair of phototransistors, like the RadioShack 276-145.

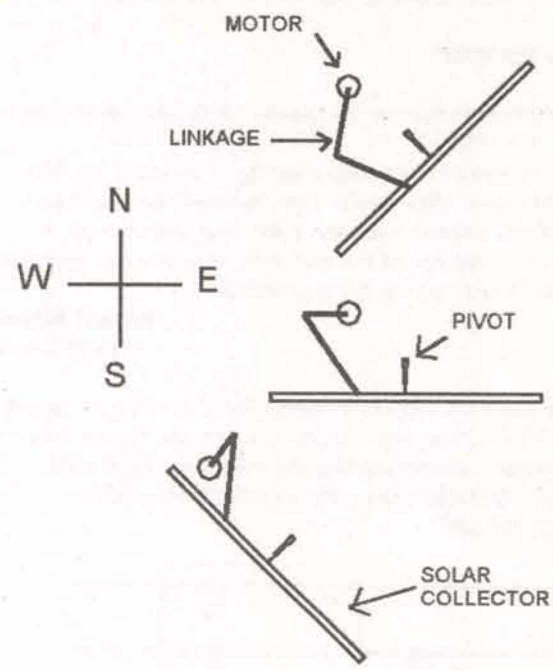


The heart of the circuit is Q2, a 2N2222A transistor, which is basically a relay driver. When the transistor is conducting, the relay, a normally-open reed relay, pulls in, which starts the motor. The two phototransistors give the relay driver some brains. Disregard Q1 for the moment. Q3 is in series with the emitter of Q2 and behaves like a variable resistor. When the photoresistor is dark, its resistance is high and very little current flows through Q2; so little, in fact, that the relay can't pull in. As light begins to fall on Q3, the transistor starts to conduct. At some point the current flow is enough to engage the relay. This photo sensor is used to determine if there is enough sunlight to warrant tracking the sun, and prevents the motor from running at night.

Q1 is the actual positioning sensor. When Q1 is dark and Q3 is bright, the relay is engaged. When light falls on Q1, it begins to conduct, which shorts out the base of Q2 causing it to turn off along with the relay. Q1 is housed in a short cylinder so that only light that hits the photo sensor straight on will trigger this process. Light off to the side of the perpendicular axis can't enter the cylinder.

Let's put this into a real-life scenario. First we have to assume that Q3 is unshieded and has full access to ambient light — which it does. As the sun comes up in the morning, the current through Q3 will begin to flow; the amount of current is proportional to the amount of light. After the sunlight is intense enough to do useful work, the relay engages and starts the motor. This point is determined by the value of R1, which has a nominal value of 100k. A potentiometer can replace R1 to adjust the trigger point. The motor will continue to run until light falls on Q1, causing Q2 to turn off. If Q1 is mounted on the rotor mechanism, this will occur when the solar tracker is pointed directly at the sun. As the sun moves across the sky, it will cast a shadow on Q1, which turns the motor back on to rotate the tracker. And so it goes until the sun sets at night and the tracker goes to sleep. The next morning Q3 awakens everybody and it starts all over again.

Most solar trackers use limit switches that reverse the direction of the motor when it reaches the ends of its sweep. Unfortunately, bi-directional motors are not easy to come by and are costly. My solution is a cam assembly that lets you use any low-speed motor. Be it AC, DC, or a hamster in a cage, it doesn't matter. All you have to do is start and stop the motor when the controller says so as the sun chariots across the sky.



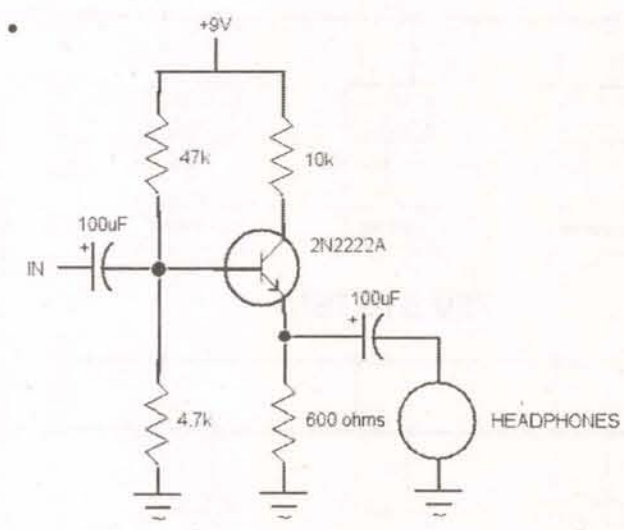
The amount of sweep is adjusted by the size of the cam and the position of the link rod. This will vary from project to project depending on the physical size and weight of the solar collector. No provisions have been made for azimuth adjustment (up/down) tilt, only the horizontal sweep. That's because the azimuth angle changes very little from day to day, and it's easily adjusted manually to compensate for the seasons. Yes, this design does require some customizing in both the ambient light level and the east-west swing, something the expensive commercial units do for you. But it's well worth the bucks saved.

Emitter Follower Fable

Q. I have a pair of 8-ohm headphones that I want to use with a Drake 2C shortwave radio with a 600-ohm output jack. How can I make the connection?

Gregory Lehmann
via Internet

A. It's usually done using a matching transformer, like the RadioShack 273-1380. However, you can also do it using a transistor amplifier stage called an emitter follower, shown below



This design was originally labeled a "cathode follower" when it was first observed in vacuum tubes. When vacuum tubes ruled the planet, somewhere around the time of T. Rex and his buddies, a cathode resistor was very often included in an amplifier circuit to establish a negative bias voltage for the grid. It was actually serendipity when one day a ham offered to share his headphone jack with a neighbor and discovered (to his surprise) that there was no loss of volume when the low-impedance headsets were paralleled across the cathode resistor. How much truth there is to that story, I don't know, but the same effect can be created by inserting a resistor in the emitter of a transistor. While this circuit can never achieve more than unity gain, it has very good impedance matching and current driving characteristics.

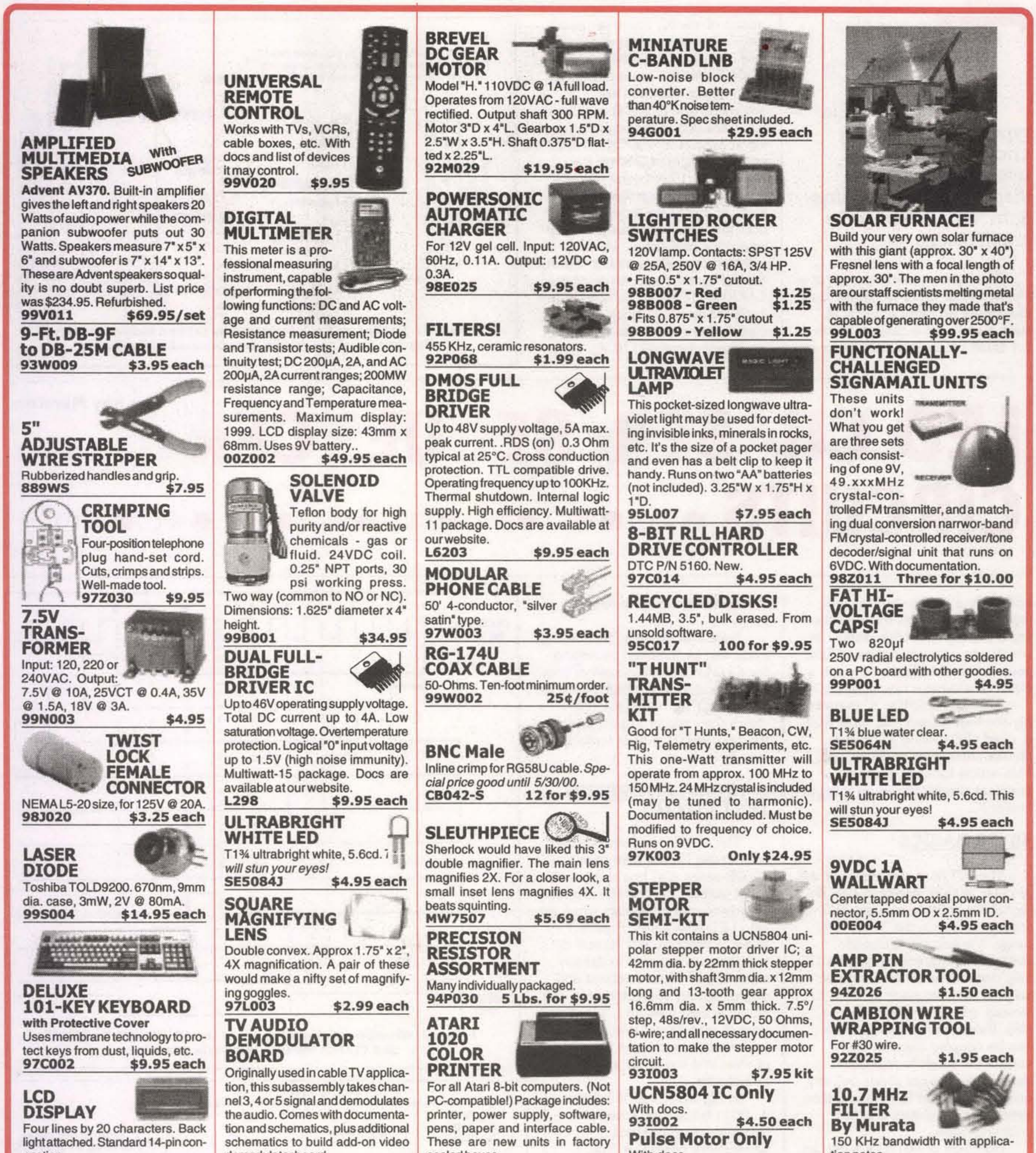
Useful Websites

Great experimenter's project and information site
www.us-epanorama.net/index.html

Have a couple of teenage hackers at home?
Here's a way to fool them into thinking Ping doesn't work.
www.pibmug.org/SEPT/ping.exe

Locate persons by birthdate
www.switchboard.com/bin/cgiqa.dll?SR=&MEM=1&F=Robert&L=Michaels&T=&S=CO&Submit=Search

Continued on page 82



Write in 78 on Reader Service Card.

LED CHASER/SEQUENCER CIRCUITS

by Ray Marston

The so-called chaser or sequencer is one of the most popular types of LED-driving circuit and is widely used in advertising displays and in running-light 'rope' displays in small discos, etc.

It consists — in essence — of a clocked IC or other electronic unit that drives an array of LEDs in such a way that individual LEDs (or small groups of LEDs) turn on and off in a predetermined and repeating sequence, thus producing a visually attractive display in which one or more ripples of light seem to repeatedly run through a chain or around a ring of LEDs.

The 4017B CMOS IC is probably the best known and most widely used LED-driving IC used in chaser/sequencer applications. This article looks at a variety of practical circuits based on this particular IC.

4017B BASICS

The 4017B is a member of the popular '4000B' family of CMOS digital ICs and can use any DC supply voltage in the 3V to 15V range. It is actually a clocked decade counter/divider IC with 10 fully decoded short-circuit-proof outputs that can each be used to directly drive a simple LED display. If desired, various outputs can be coupled back to the IC control terminals to make the device count to (or divide by) any number from two to nine and then either stop or re-start another counting cycle.

Numbers of 4017B ICs can be cascaded to give either multi-decade division or to make counters with any desired number of decoded outputs. The 4017B is thus an exceptionally versatile device that can easily be used to chase or sequence a basic LED display of virtually any desired length.

Figure 1 shows the outline, pin notations, and basic functional diagram of the 4017B, and *Figure 2* shows the waveform timing diagrams of the IC, which incorporates a five-stage Johnson counter and has CLOCK, RESET, and CLOCK INHIBIT input terminals. The internal counters are advanced one count at each positive transition of the input clock signal when the CLOCK INHIBIT and RESET terminals are low. Nine of the 10 decoded outputs are low, with the remaining output high, at any given time. The outputs go high sequentially, in step with the clock signal, with the selected output remaining high for one full clock cycle. An additional CARRY OUT signal completes one cycle for every 10 clock input cycles, and can be used to ripple-clock additional 4017B ICs in multi-decade counting applications.

Note that the 4017B counting cycle can be inhibited by setting the CLOCK INHIBIT terminal (pin 13) high, and that a high signal on the RESET terminal (pin 15) clears the counter to zero and sets the decoded '0' output terminal (pin 3) high.

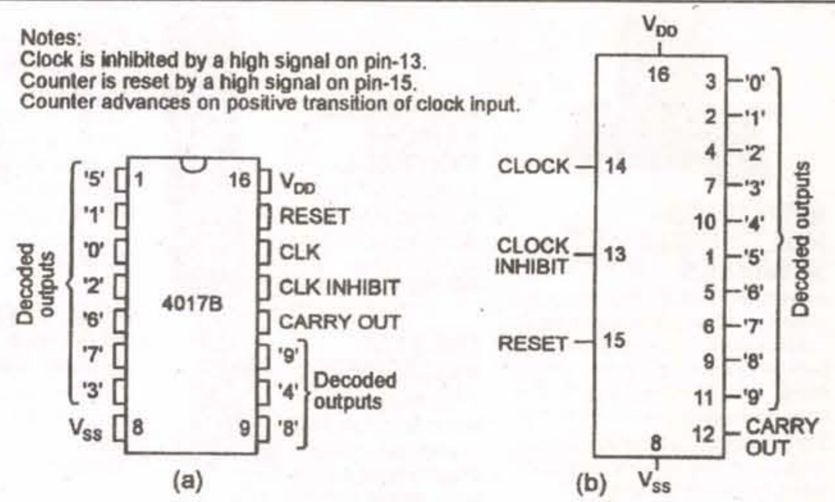


Figure 1. **Outline and pin designations (a) and basic functional diagram; (b) of the 4017B decade counter/divider IC.**

A 4017B LED-DRIVING TEST CIRCUIT

The 4017B is a versatile and easy-to-use IC and (like most 4000B-series ICs) has short-circuit-proof outputs that exhibit slightly surprising characteristics when driving LED-type loads. *Figure 3* shows a practical 4017B test circuit that can be used to demonstrate the IC's basic actions and output-driving characteristics. The circuit is best built on a 'plugblock' type of breadboard unit, in which components and wires are simply pushed into the unit's sprung-contact blocks.

In *Figure 3*, the 555 timer IC (IC1) is used as a variable-frequency asymmetrical squarewave generator that feeds clocking signals to the CLK input terminal of the 4017B IC (IC2). This output waveform is normally high, but briefly flips low once per cycle and drives LED5 on. The 4017B's internal switching actions are initiated as this signal flips high again and LED5 switches off. Note that the clocking signal is fed to the 4017B IC via removable Link A, and can thus be physically

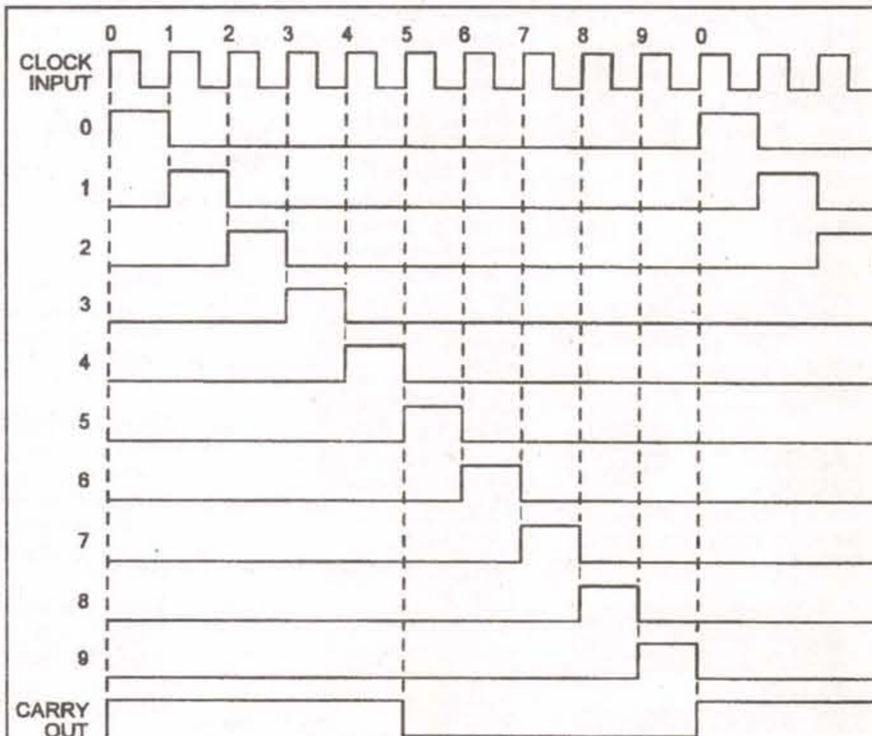


Figure 2. **Waveform timing diagram of the 4017B with its RESET and CLOCK INHIBIT terminals grounded.**

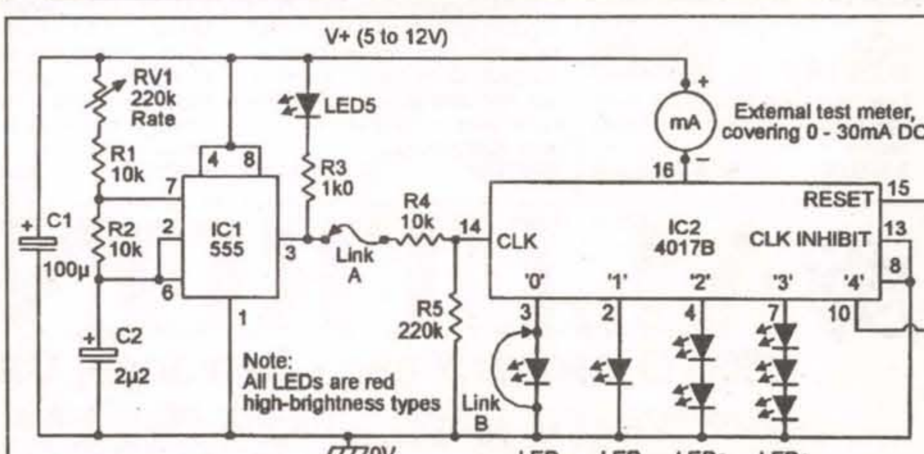


Figure 3. **A 4017B LED chaser/sequencer test and demonstration circuit.**

interrupted whenever required; R4 and R5 protect the 4017B's input against damage when Link A is open or IC2's positive supply connection is broken.

In *Figure 3*, the positive DC supply line is connected to pin 16 of the 4017B IC via an external multi-range DC current meter that (since IC2's quiescent current is negligible) gives a direct readout of the current drawn by the IC's *currently-active* output load. The 4017B is wired (via pins 10 and 15) in the 'divide-by-four' mode and sequentially drives four sets of output loads, which are notated '0' to '3.'

Output '0' takes the form of a single LED when Link B is open, or a short-circuit when Link B is closed. Output '1' takes the form of a single LED. Output '2' takes the form of two series-connected LEDs. Output '3' takes the form of three series-connected LEDs. All LEDs are red high-brightness types.

When construction of the *Figure 3* circuit is complete, close Link A, open Link B, connect the meter in place, and connect the unit to a 9V DC supply. Adjust RV1 to give a slow clocking rate, noting that LED5 gives a brief flash during each cycle, and that all other LEDs or groups of LEDs activate sequentially. You will probably be surprised to note that all of the display LEDs (LEDs 1 to 4) operate at almost equal brightness, and that all output loads produce fairly similar current readings on the test meter.

When testing the *Figure 3* circuit, you can check the individual load currents by waiting until the load activates and then 'freezing' the display by opening Link A. When load '0' is active, the load current is typically 17.5mA with Link B open or 19mA with Link B closed; the load '2' and load '3' currents are typically 16mA and 12.5mA, respectively. Thus, when using a 9V supply, the load current is typically 19mA when driving a short-circuit, or 12.5mA when driving three series-connected red LEDs. The graphs of *Figures 4* and *5* help explain this circuit action.

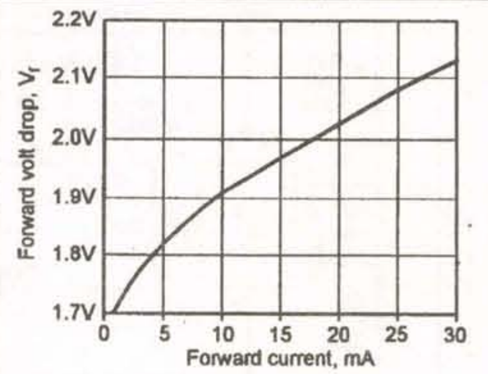


Figure 4. Typical forward current/voltage graph of a high-brightness red LED.

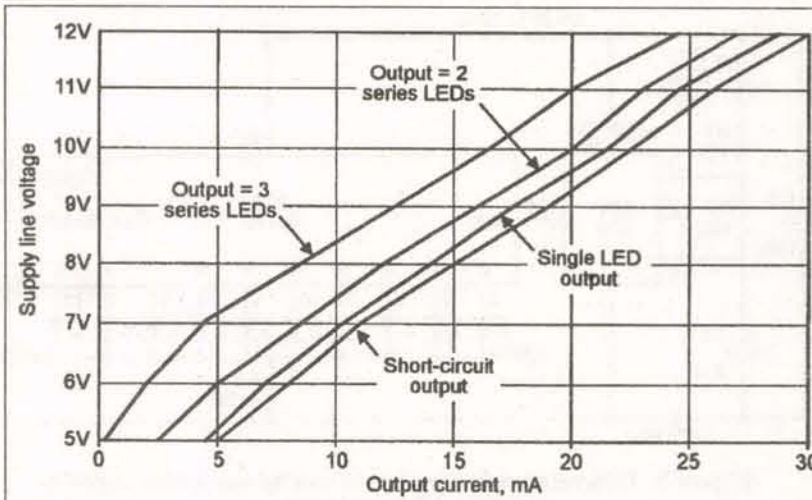


Figure 5. Typical supply voltage versus output current graph of the Figure 3 circuit when driving different types of loads.

Figure 4 shows the typical forward current/voltage graph of a high-brightness red LED. Note that large variations in forward current produce relatively small variations in forward voltage. Thus, when the current is increased from 10mA to 30mA, the forward voltage increases by only 0.22V and, in this case, the LED thus acts like a pure voltage (zero impedance) load in series with an 11-ohm impedance. In practice, this impedance varied between 10 and 15 ohms over most of the LED's working current range.

Figure 5 shows the typical supply voltage versus output current graph that applies to each output of the *Figure 3* circuit when driving different types of loads.

Note that each CMOS output stage acts like a loosely-controlled constant-current generator that has its short-circuit output current determined by the supply voltage value, but has its LED-driving current value influenced by the actual Vout value of the stage.

In the *Figure 3* circuit — when

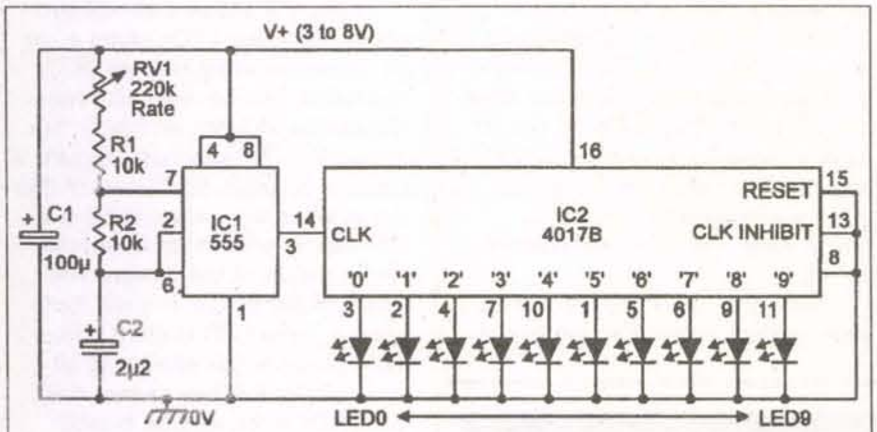


Figure 6. A 10-LED chaser/sequencer can be used with supply voltages up to only 8V and produces a moving dot display.

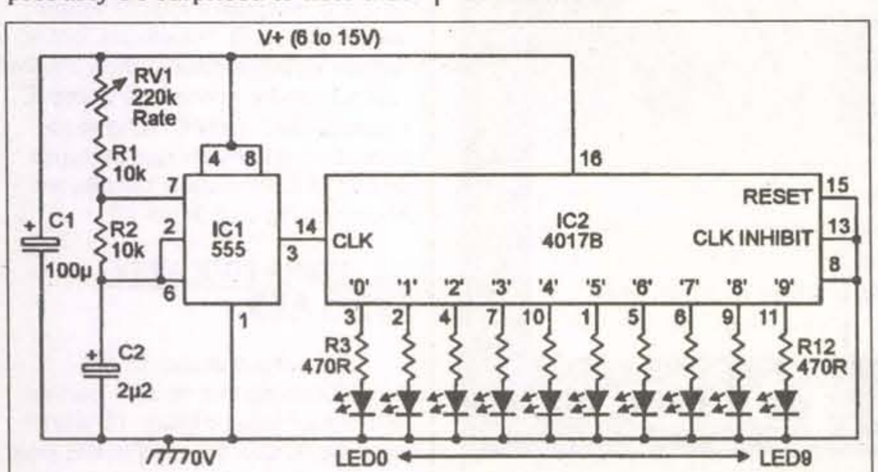


Figure 7. This version of the 10-LED chaser can be used with any supply up to 15V.

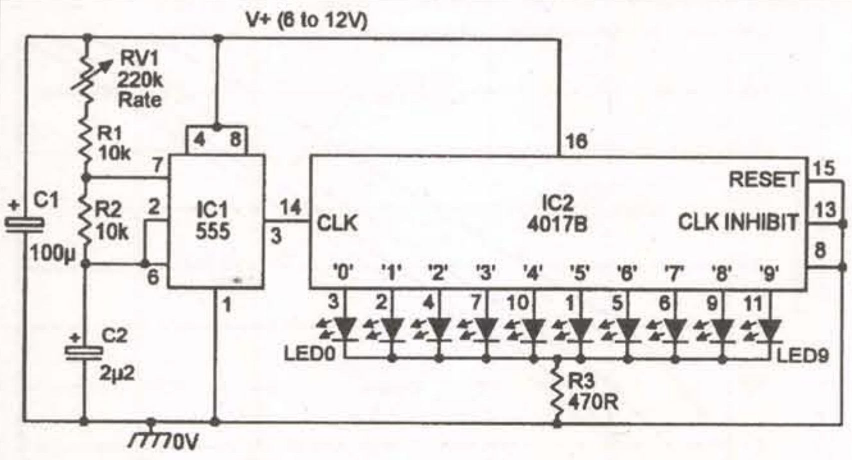


***Figure 8.* This version of the chaser can be used with supplies up to 12V maximum.**

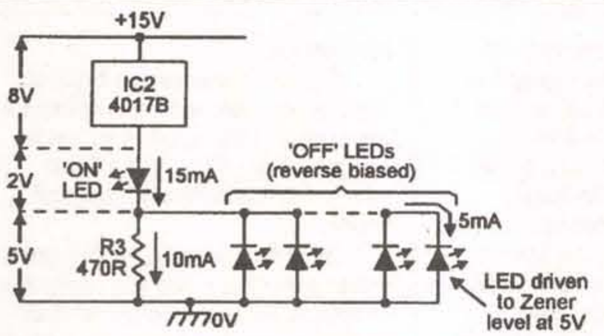


***Figure 9.* Possible equivalent of the *Figure 8* circuit when powered from a 15V supply.**

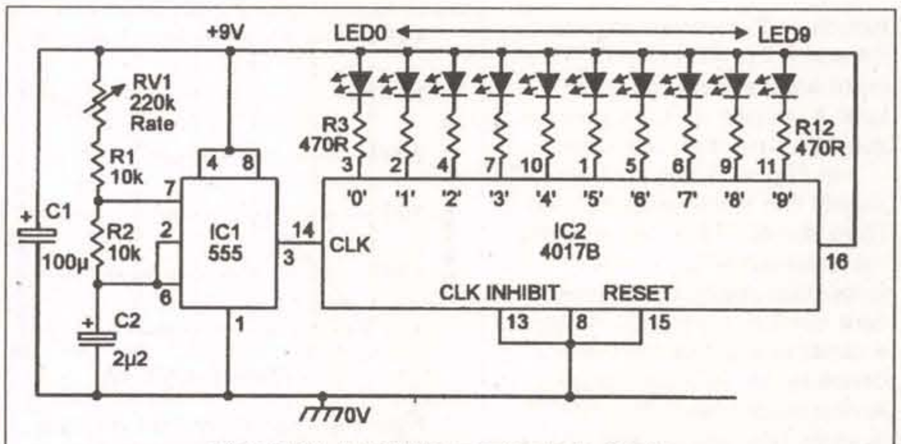


***Figure 10.* A 10-LED moving hole display.**

using a 9V supply — Vout is zero when driving a shorted output and, under this condition, 9V is developed across the output stage, Iout is 19mA, and 171mW is thus dissipated in the output stage. When, on the other hand, the 9V circuit is driving three series-connected LEDs, Iout is 12.5mA, Vout is 5.85V (see *Figure 4*), 3.15V is developed across the output stage, and less than 40mW is thus dissipated in the output stage.

Note that most 4000B-series CMOS data sheets list the maximum permitted DC power dissipation values of the 4017B IC as 100mW per-output-stage and 500mW per-package, and these figures should be kept in mind when experimenting with the *Figure 3* test/demonstration circuit.

PRACTICAL 4017B CHASER/SEQUENCER CIRCUITS

Figure 6 shows the practical circuit of a 4017B 10-LED chaser in which IC1 acts as a variable-rate clocking generator and the 4017B IC is wired into the decade counter mode by grounding its CLOCK INHIBIT (pin 13) and RESET (pin 15) control terminals. The circuit action is such that the visual display appears as a moving dot that repeatedly sweeps from the left (LED0) to the right (LED9) in 10 discrete steps as the 4017B outputs sequentially go high and drive the LEDs on. The LEDs do not, of course, have to be connected in a straight line; they can, for example, be arranged in a circle, in which case, the circle will seem to rotate.

Note that the *Figure 6* circuit relies on the internal action of the 4017B to limit the LED currents to safe values, and this circuit can thus be safely used with supply voltages up to a maximum of only 8V without risk of exceeding the IC's 100mW per-output-stage power dissipation limits.

Figure 7 shows a modified version of the above circuit, in which a current-limiting 470-ohm resistor is wired in series with each LED to help reduce the IC's power dissipation to a safe level. This circuit can use any DC supply in the 6V to 15V range.

Figure 8 shows a circuit variant in which the LEDs share a single current-limiting resistor (R3) and which can be used with reasonable confidence at supply values up to 12V maximum. *Figure 9* shows a possible equivalent of this circuit when it is powered from a 15V supply and which illustrates the limitation of the design. The action of the 4017B is such that, when a given LED is on, it effectively grounds the anodes of all other LEDs; R3 thus causes the 'off' LEDs to be reverse biased. Because of the low reverse-voltage ratings of LEDs, this action can cause one or more of the 'off' LEDs to zener at about 5V, thus giving the results shown in the diagram and possibly causing a power overload in the IC's active output stage.

Thus, when the 4017B is used to drive simple 'one-LED-per-output' displays in the moving dot mode, the LEDs can be connected directly to the IC outputs if supply values are limited to 8V maximum, but at supply voltages greater than 8V, the LEDs must be connected to the IC outputs via current-limiting resistors. A variety of alternative types of 4017B LED display circuits are shown in *Figures 10* to *15*.

ALTERNATIVE LED DISPLAYS

The output stages of the 4017B can source or sink current with equal ease. *Figure 10* shows how the IC can be used in the sink mode to make a moving hole display in which nine of the 10 LEDs

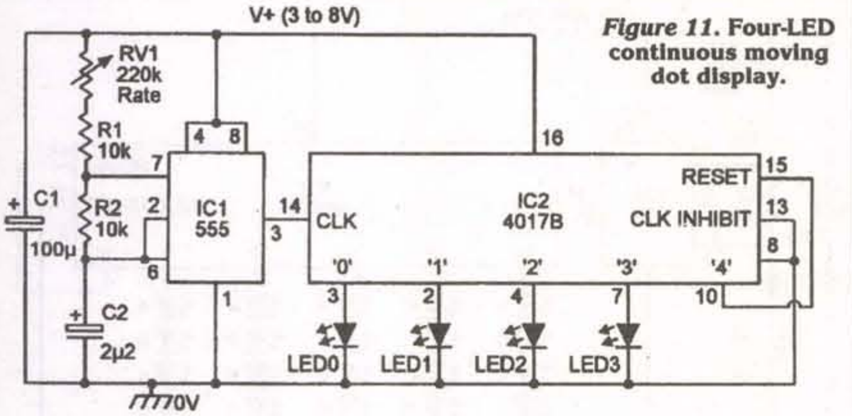


Figure 11. **Four-LED continuous moving dot display.**

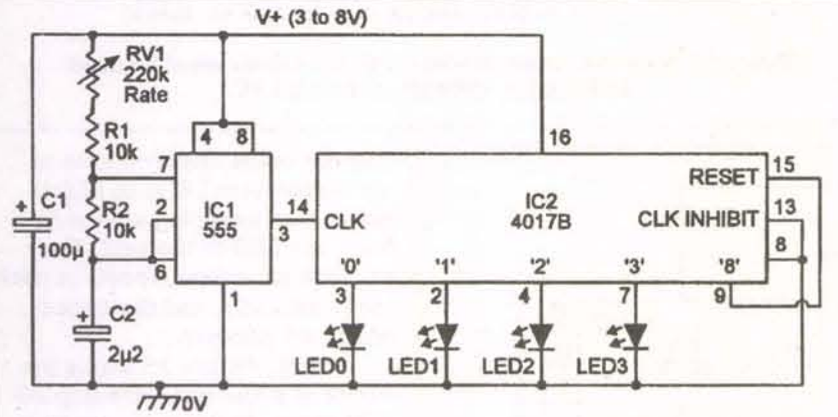
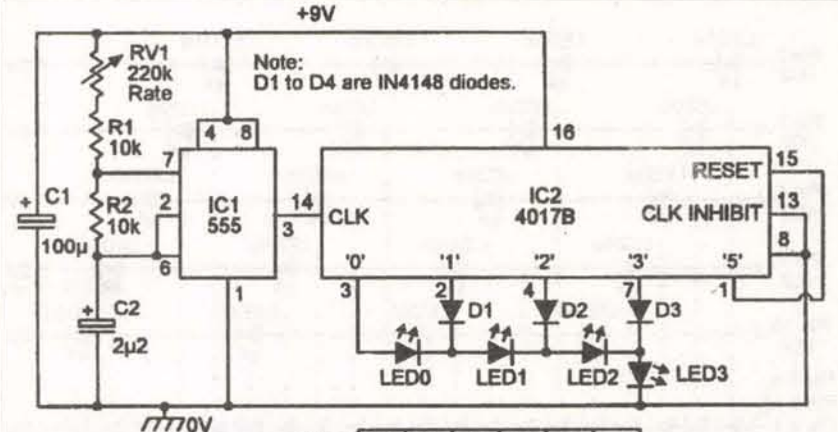


Figure 12. **Four-LED intermittent moving dot display with 50% blank period.**



LED0	O	●	●	●	●	O
LED1	O	O	●	●	●	O
LED2	O	O	O	●	●	O
LED3	O	O	O	O	●	O
	1	2	3	4	5	1

Step number

O = ON
● = OFF

Figure 13. **Circuit and performance table of a four-LED five-step sequential turn-off display.**

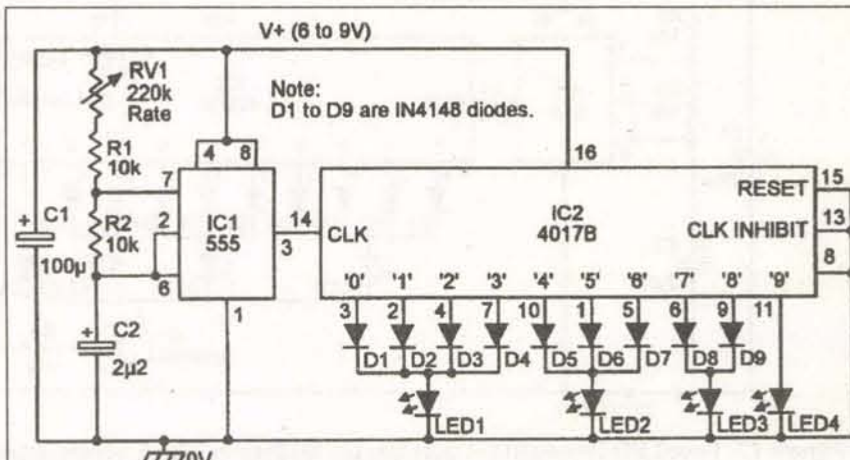


Figure 14. **Four-LED continuous accelerator display in which the pattern seems to accelerate from left to right.**

are on at any given time, with single LEDs turning off sequentially. If the LEDs are wired in the form of a circle, the circle will seem to rotate. Note that, since all LEDs except one are on at the same time, each LED must be provided with a current-limiting resistor, to keep the IC power dissipation within safe limits.

In practice, moving dot displays are far more popular than moving hole types. If desired, moving dot displays of the *Figure 6* type can be used with fewer than 10 LEDs by simply omitting the unwanted LEDs but, in this case, the dot will seem to move intermittently, or to scan, since the IC takes 10 clock steps to completely sequence and all LEDs will thus be off during the unwanted steps.

If a continuously-moving less-than-10-LED display is wanted, it can be obtained by wiring the first unused output terminal of the 4017B to its pin 15 RESET terminal, as shown, for example, in the four-LED circuit of *Figure 11*. Alternatively, the circuit can be made to give an intermittent display with a controlled number of OFF steps by simply taking the appropriate one of the unwanted outputs to the pin 15 RESET terminal. In *Figure 12*, for example, the LEDs display for four steps and then blank for four steps, after which the sequence repeats, thus giving a moving dot display with a 50 percent blank period.

Figure 13 shows a rather unusual and very attractive four-LED five-step sequencer in which all four LEDs are initially on but then turn off one at a time until eventually (in the fifth step) all four LEDs are off; the sequencing details are given in the table in *Figure 13*. Note in this circuit that the LEDs are effectively wired in series and that the basic circuit cannot be used to drive more than four LEDs.

Figure 14 shows another unusual and attractive LED display.

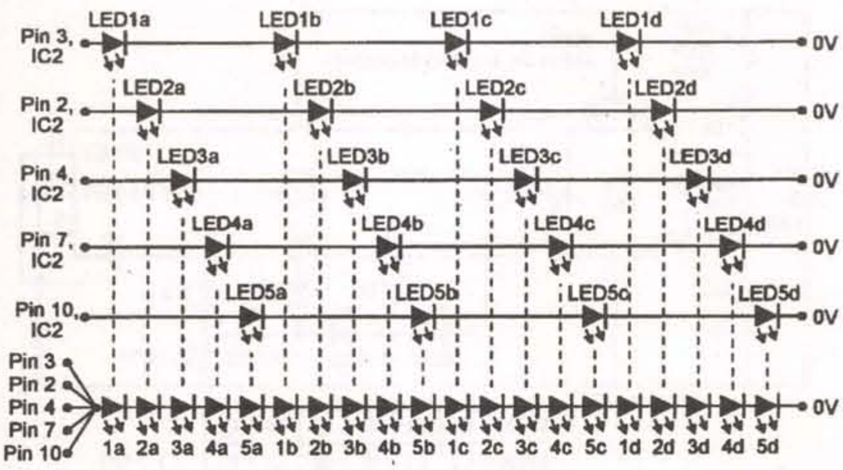


Figure 16. **Basic method of constructing a five-strand 20-LED light-rope display for use with the *Figure 15* circuit.**

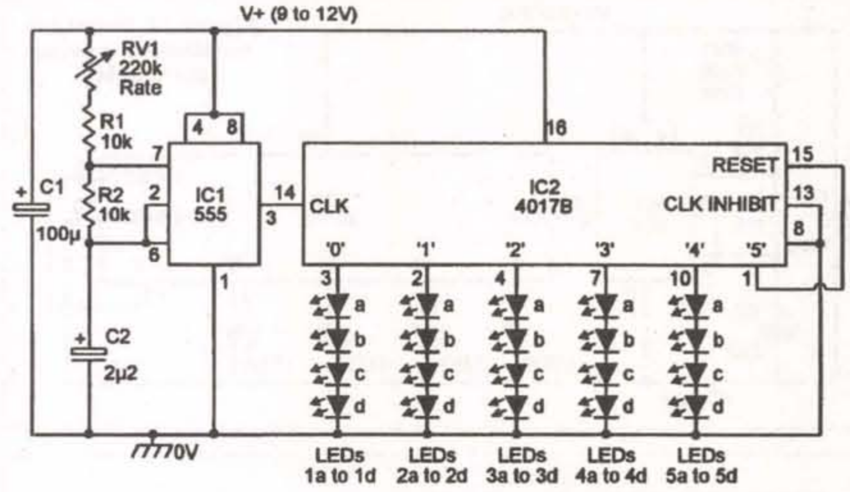


Figure 15. **This four-bank five-step 20-LED chaser must be used with supply voltages of at least 9V.**

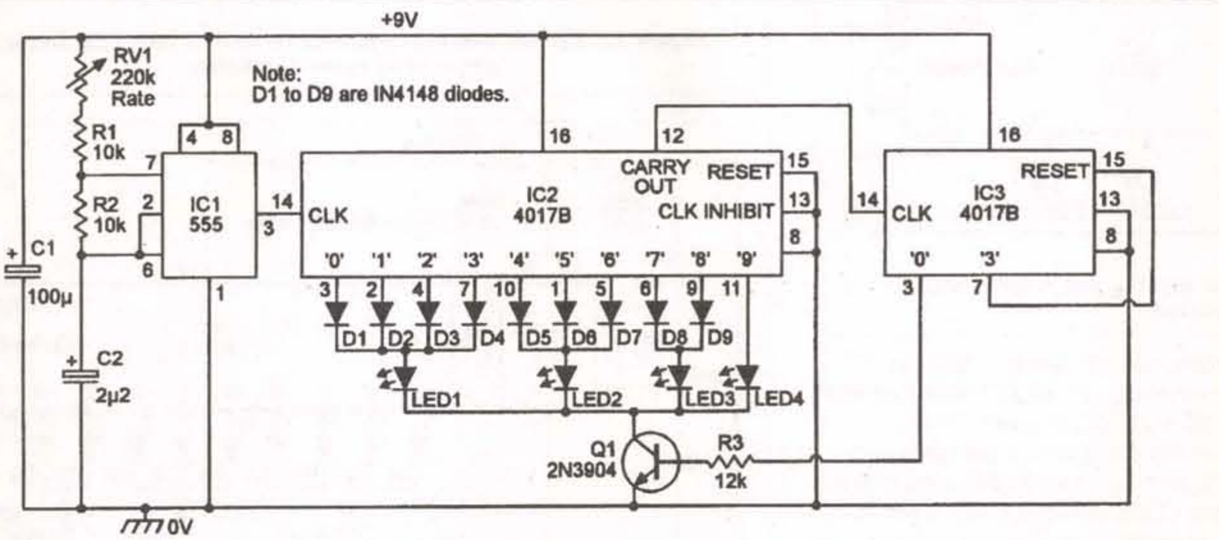


Figure 17. **Four-LED intermittent accelerator display in which acceleration occurs for 10 clock steps in every 30.**

In this case, the 4017B runs through a 10-step sequence, with LED1 on for steps 0 to 3, LED2 on for steps 4 to 6, LED3 on for steps 7 and 8, and LED4 on for step 9. The consequence of this action is that the visual display seems to accelerate from LED1 to LED4, rather than sweeping smoothly from one LED to the next. The acceleration action repeats in each switching cycle, and the cycles repeat ad infinitum.

Finally, *Figure 15* shows the circuit of a four-bank five-step 20-LED chaser that can be used as the basis of a variety of attractive LED displays. Note that a bank of four LEDs are wired in series in each of the five used outputs of the IC, so four LEDs are illuminated at any given time. Roughly 2V are dropped across each ON LED, giving a total drop of 8V across each ON bank, and the circuit's supply voltage must thus be greater than this value for the circuit to operate. A greater number of LEDs can be used in each bank if the supply voltage value is suitably increased.

One of the most attractive and popular LED sequencer displays is the 'light-rope' type, and *Figure 16* shows the basic method of constructing a five-strand 20-LED light-rope display that can be driven by the *Figure 15* chaser circuit. Here, each group of four series-connected 'step' output LEDs of the *Figure 15* chaser circuit forms one 'strand' of the light rope. There are five strands, and each one must be color-coded to enable it to be connected to the correct output pin of the 4017B IC. In each strand, the four LEDs are evenly spaced apart, but are offset relative to the other four strands, so that there is an equal spacing between all 20 LEDs when the five strands are wrapped together (as shown at the bottom of *Figure 16*) to form the complete light-rope, which is usually threaded through a length of protective clear plastic tubing.

If a light-rope of this type uses a fixed spacing of (say) five inches between its LEDs, it will have a total length (allowing for a few unused inches at each end) of about eight feet. When the display

is active, four evenly spaced ripples of light seem to run continuously along the length of the lightrope, which is driven directly from the output of the *Figure 15* chaser circuit.

DISPLAY MULTIPLEXING

The basic action of the *Figure 14* four-LED 'accelerator' circuit is such that the light display seems to repeatedly accelerate from left to right, taking a total of 10 clock cycles to complete each sequence. *Figure 17* shows how the circuit can be modified to give an intermittent display in which the visual acceleration action occurs for 10 clock cycles, but all LEDs then blank for the next 20 cycles, after which the action repeats. The circuit action is as follows.

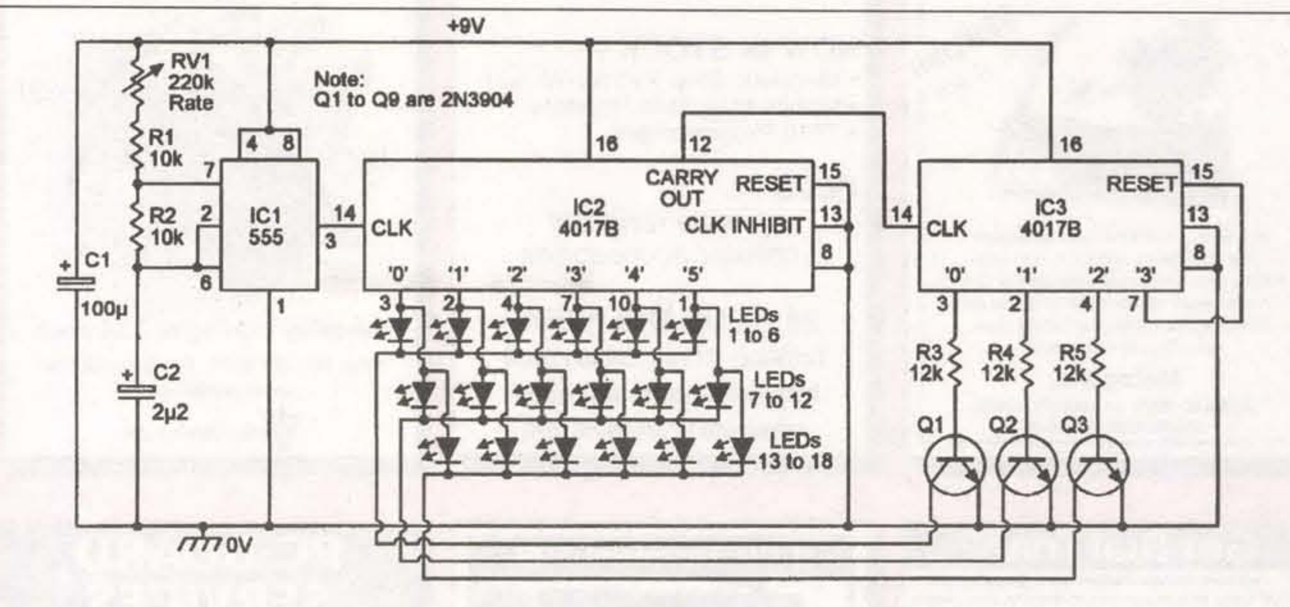


Figure 18. **Multiplexed six-LED x three-line moving-dot display. The dot moves intermittently along the lines.**

The 4017B has a CARRY OUT terminal on pin 2. When the IC is used in the normal divide-by-10 mode, this CARRY OUT terminal produces one output cycle each time the IC completes a decade count. In *Figure 17*, this signal is used to clock a second 4017B (IC3), which is wired in the divide-by-3 mode with its '0' output fed to the base of gating transistor Q1. Consequently, during the first 10 clock cycles of a sequence, the '0' output of IC3 is high and Q1 is biased on, so IC2 acts in the basic manner already described for *Figure 14*, with its LEDs turning on sequentially and passing current to ground via Q1. After the 10th clock pulse, however, the '0' output of IC3 goes low and turns Q1 off, so the LEDs no longer illuminate even though IC2 continues to sequence. Eventually, after the 30th clock pulse, the '0' output of IC3 again goes high and turns Q1 on, enabling the display action to repeat again, and so on.

The *Figure 17* circuit is a simple example of display multiplexing, in which IC3 and Q1 are used to selectively enable or disable a bank of LEDs.

To conclude this article, *Figure 18* shows another example of a display multiplexing circuit. In this case, the display consists of three lines of six intermittently-sequenced LEDs, and these lines are sequentially enabled via IC3 and individual gating transistors, with only one line enabled at any one time.

Note that the basic *Figure 18* circuit can easily be expanded to control up to 10 sequentially-activated lines, which can each have up to 10 LED-driving outputs. The expanded circuit can thus be used as a chaser/sequencer with up to 100 LED-driving outputs. **NV**

PCB EXPRESS, INC.

"PROTOTYPE TO PRODUCTION"

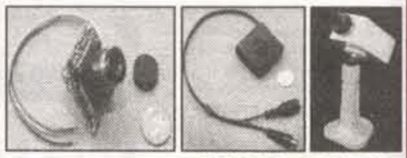
S/SIDED: 5-days, 10 Pcs.	$275.00
D/SIDED: 5-days, 5 Pcs.	$300.00
D/SIDED: 5-days, 10 Pcs.	$350.00
4-LAYERS: 5-days, 5 Pcs.	$750.00
4-LAYERS: 7-days, 10 Pcs.	$850.00
6-LAYERS: 5-days, 5 Pcs.	$950.00
6-LAYERS: 7-days, 10 Pcs.	$1,175.00

(Up to 30 sq. inch each, includes Tooling)

"SERVICES" *– UL Approved*
SMOBC, LP1 mask & Legend
Photoplotting, Electrical Testing
Thru hole/SMT, Gold/Nickel Plating
Routing and Scored Panel, Instant Quotes

PH: **(888) 427-2920**, Fax **(847) 427-1949**
E-Mail: cir1920@aol.com
LOWEST COST & FAST DELIVERY

VIDEO PRODUCTS



CNL-100	BX-120-P	SX-800
$49	$59	$79

- 430 TV Lines Resolution
- 9-14 VDC Operation
- Infrared Sensitive
- SX-800 has Audio Output
- A-300 Camera Enclosure also available

MATCO, INC.
Schaumburg, IL
1-800-719-9605 • 1-847-619-0852 FAX
E-Mail – info@mat-co.com
Website – www.mat-co.com

10&14 Hour Telephone Recorders

Starting at **$69** +$6.95 S/H

Times based on a 180 tape
14 Hour $89+S/H

120 Tape included!

Automatically starts recording when the phone is picked up and stops when you hang up. Records both sides of the conversation!
Printed catalog $3 (free with order)

Visit our Online Catalog
www.mscelectronics.com

MSC Electronics
PO BOX 461 Jessup, MD 20794
(301) 497-1600
FAX (301) 497-1925
No Checks • US & Canada Only

VISA MasterCard

EPS

EPROMS AS LOW AS **25¢**

27C256	27C040	27C1024	87C51
27C512	27C400	28F010	8751
2732A	27C4096	28F020	8755
27C32	574000	28F040	MC68HC70 5C8A
27C128	574200	8749H	PIC16C56
27C64	27C402	8748H	PIC16C54
2716	27C020	8741	PIC16C622
2708	27C210	8742	GAL16V8
27C512-90	27C010	8744	GAL22V10

STATIC RAM
HM628128
62256
6264
6116

PROCESSOR
8255
8254
80C31

MEMORY
D-RAMS
SIMM

- Many more parts in stock
- All major brands
- All guaranteed

E-Mail: eproms@aol.com
TEL: (818) 774-9444 · FAX: (818) 774-0822
WE BUY EXCESS INVENTORY

FREE SAMPLE COPY!

ANTIQUE RADIO CLASSIFIED

Antique Radio's Leading Monthly Magazine

Articles – Classifieds – Ads for Parts & Services. Also: Ham Equip. – Books – Telegraph – 40's, 50's & 60's Radios – Early TV – Auction Reports & more...

1-Year: $39.49 ($57.95 by 1st Class)
6-Month Trial - $19.95. Foreign - Write.
A.R.C., P.O. Box 802-G23
Carlisle, MA 01741
Call: 978-371-0512 — Fax: 978-371-7129
Web: www.antiqueradio.com

SINGLE SIDED PCBS 9¢ / DOUBLE SIDED PCBS 14¢

9¢ PER SQUIN, $100 SET UP, SMOBC, ONE OUNCE COPPER, PC 75, 1/16", ONE SOLDER MASK AND ONE SILK SCREEN. NEGATIVES $50.

14¢ PER SQUIN, $100 SET UP, PTH, ONE OUNCE COPPER, FR4 1/16", TWO SOLDER MASK AND ONE SILK SCREEN. NEGATIVES $75.

PLEASE VISIT OUR WEB SITE FOR MORE INFORMATION AND OTHER PRICE EXCEPTIONS WWW.VANDVMACHY.COM

* THESE PRICES APPLY ONLY TO RECTANGULAR PCBS.

V&V MACHY & EQUIP. INC

V&V MACHY AND EQUIP. INC. (HOUSTON TX. OFFICE)
PH. (281) 397 6220
MARKETING TECH. S.A. (MEXICO PLANT)
PH. 011 525 3613351, FAX 011 525 3615996

Stereo Zoom Microscope

Zoom range 7.5X to 34X
Heavy duty black base
Fluorescent ring light included
Order #SZIM3400 — $795.00

Other inspection microscopes available. Call for catalog.

Eagle Instruments, Inc.
20 Adrian Ct., Burlingame, CA 94010
Tel: 650-697-2955 Fax: 650-697-9207

ASSEMBLY & ENGINEERING

Producible designs since 1970

Contract Engineering
- Embedded Microprocessors
- PCB Layout and Packaging Design
- Analog including RF to 1 GHz
- Instrumentation
- A/D and D/A

Contract Assembly
- High-Speed Fuji Surface Mount
- Through hole
- Turn-key or Kit
- Run sizes one through thousands
- Test and burn-in available

Bilocon Corp.
800-736-5927
425-353-2276
www.bilocon.com

Seabird Technical

Ph 650/367-8320
Fx 650/365-5845
VISA
MC

3580 Haven Ave.
Redwood City, CA 94063-4603

STEREO MICROSCOPE

Model ST 251A
10X and 30X
4 in. Throat
Top & Bottom light
Dust cover
Eyecups
5 year warranty
$ 250.00

CONTROL · MEASURE · INPUT

MODEL 40–$109

- RS-232 interface
- 28 lines digital I/O
- Eight analog inputs
- PWM output
- Three stepper ports

MODEL 100–$279

- 12-bit 100KHz A/D
- Four analog outputs
- Three timer counters
- 24 digital I/O

PRAIRIE DIGITAL, INC.
920 SEVENTEENTH ST., INDUSTRIAL PARK
PRAIRIE DU SAC, WI 53578
TEL: (608) 643-8599 · FAX: (608) 643-6754

Specializing in hard-to-find, pre-owned, electronic parts, components and systems

Monitors, 13"- 21"	RF/Microwave
Computer Systems	Specialty Equipment
Disk Drives	Test Equipment
CPU's	Measurement Equipment
PC Peripherals	Too many items to list

Stock is continually changing.
Check our web site for current inventory and pricing.

www.dmdsystems.com

DMD Systems Recovery, Inc. 602 305.8485
fax 602 305.8485 info@dmdsystems.com

CABLE CONVERTS

TV86/3	86/CH	TV86/3V/A
TRIVISON 550/3		$37.95
VIEW MASTER 2600		

125 CHANNEL UNITS

TRI 860/3	10 LOT	$49.95
TRI 860/3V/A	10 LOT	$59.95
V/MASTER	3800/3V/A	

FOSS WAREHOUSE DIS
289 SCHENCK ST
N TONAWANDA NY 14120
800-473-0506
800-488-0525 FAX
716-694-6400 716-693-4322 FAX
E/M FOSS@BUFFNET.NET
WEB PAGE: WWW.FOSSW.COM
NO DISCRAMBERS ONLY CABLE CONVERTS

GRADE "A" CD RECORDABLE DISKS

DIAMONDBACK CD-R

DISK TYPE	QTY	EA	SPINDLE
74 Min. 650MB (on spindle)	100	.79	$79.00 Silver/Silver
80 Min. 700MB (on spindle)	100	$1.29	$129.00 Silver/Blue

- Excellent for Music and Data Integrity
- Reliable OEM Quality

Call Toll Free 1-(888) 967-8400

RISK FREE DISKS, INC.
— OUR 20TH YEAR —
www.riskfreedisks.com

VISA MasterCard DISCOVER

SOLAR ENERGY!

SIEMENS SOLAR PANELS

MODEL	WATTS	SUGG. PRICE	OUR PRICE!	SHIPPING
SP65	65	$472	*$322*	
SP75	75	$500	*$359*	
SM55	55	$410	*$293*	*FREE*
SR50	50	$360	*$259*	*SHIPPING!*
SR90	90	$635	*$437*	
SR100	100	$640	*$464*	

All Siemens' Solar Panels are Available!
Quantity Discounts Available!

RV SOLAR POWER KITS

WATTS	SUGG. PRICE	OUR PRICE!	SHIPPING
36	$499	*$350*	
50	$599	*$445*	*FREE*
75	$799	*$595*	*SHIPPING!*
100	$999	*$735*	

74 page Renewable Energy catalog - $5

GeneSys Resources, Inc.
P.O. Box 311, Newport, MI 48166-0311
734-552-2074

www.gri2000.com

SMARTCARD

DEVELOPMENT KIT
INCLUDES: UNIVERSAL PROGRAMMER, POWER SUPPLY, DB9 CABLE DEVELOPMENT SOFTWARE, 4 BLANK BASIC SMARTCARDS.
KIT $200.00 + SHIPPING
EXTRA CARDS $20.00 EACH OR 8/$100.00
SOFTWARE INCLUDED.
POSSIBLE APPLICATIONS INCLUDE:
IDs, COMPUTER SECURITY, SECURE DATA, MEDICAL RECORDS, ETC.
NOT FOR USE WITH DSS TV
Call TONY at
WIZARD ENGINEERING
1-419-385-3100

reader FeedBack

Continued from page 14

is poor. I am surprised Electronic Rainbow can offer the kit for sale.

The DC resistance of a telephone must be greater than 10 megohms. The load a telephone places on a line is condensed into a ringer equivalence number (REN); you will find this number stated on every phone. A telephone's REN must be less than 5; my desk phone's REN is 0.2.

The Busy Lite's REN is about 500. The telephone company periodically (and automatically) tests for trouble on its telephone lines, and it will notice the high REN. Attach 10 Busy-Lites to your telephone line, and some central offices may think you went off hook.

Type 68 interfaces have other requirements to protect the user and the telephone company, such as no exposed metal, 1,500-volt isolation, and transient tolerance. Tip and ring have stringent balance requirements, and hooking the Busy-Lite to a grounded supply will upset that balance and possibily disable your telephone service.

Even if we ignore regulatory requirements, the circuit design is poor.

When a phone goes off hook, Q1 turns off. Q2 turns on. If Q2 turns on hard, then D1, D2, and Q2 are a direct short across the battery. The battery internal resistance will limit the current, and the battery life will be poor.

If the current limits at 100mA, the 9V battery will last about two and one-half hours off-hook. Talk to your ISP too long, and the battery is gone.

A better design replaces D2 with a 1K resistor, so the battery current will always be less than 9mA, and the battery will last for 25 off-hook hours. To get longer life, reduce the LED current and/or flash the LED at a low duty cycle. The battery savings will pay for additional complexity. Flashing 1.8mA at 10% duty cycle will give you more than 1,000 hours off hook. Use an inductor and get even more time.

The on-hook performance isn't great either. There will be about 3V across R3, so the current drain on the battery is 60uA. If the battery capacity is 200mA-hr, then the lifetime is about 140 days. My watch uses a much smaller battery and runs for three years. A good circuit design would set the quiescent current drain below 10uA.

The project has many serious flaws and should not be used.

Gerald Roylance
via Internet

Fred's response ...

Regarding Gerald Roylance's comments about my Telephone Busy Lite construction project, I have no argument with any of his comments.

Mr. Roylance is a very capable and well-recognized author, and it is apparent from his previous articles and letters in *Nuts & Volts* — and his specific analysis and suggestions concerning the Telephone Busy Lite — that his technical knowledge is well beyond most experimenters and hobbyists.

This article was my attempt to clarify operation and offer modifications to a useful device that Electronic Rainbow has been offering in kit form for years, and for which no similar commercial device was available. It was intended for experimenters and hobbyists, with several suggested changes.

I assumed the Electronic Rainbow design satisfied telephone interface requirements ... which were greatly relaxed since the CarterPhone decision many years ago involving the use of telephone answering machines.

Previous to that decision, any device being connected to the phone lines had to use a special interface installed by the telephone company.

Mr. Roylance's suggested circuit changes seem valid, especially with respect to battery drain. You'll note that my article made several suggestions about using external power rather than battery power.

As a final note, I have personally been using three of these Telephone Busy Lite's, built from unmodified Rainbow kits, but using external power rather than batteries, since August of 1999, with no observed telephone problems.

Fred "Spark" Blechman

AMATEUR ROBOTICS NOTEBOOK

by Robert Nansel

As I write, we are still up to our hips in boxes here at the new Robot Ranch. I have had *zero* time for robotics the past four weeks, so I won't be talking about IC H-bridges this time as I promised. Nor will I be announcing a winner yet for the Second Lonely Gearhead Contest.

For one thing, I haven't had time to tabulate all the entries received to date and, for another, I haven't yet gotten a bound copy of the prize I promised (Karl Lunt's new book). AK Peters, the publisher of Karl's book, graciously provided me with a prepress copy to review, but that will have to wait till next month because I haven't had time to read it either.

Therefore, by fiat I'm extending the time to send in your contact information if you are looking for a local robotics club, or your robotics club contact information if I haven't already included you in my club listing. Send your information in by May 1, 2000 and you'll be eligible for the drawing.

In my packing I did, however, come across a bunch of interesting motor driver and controller boards I built in the early 90's. They all use an interface scheme called ROBBI.

First some background.

Throughout the 25-year history of the modern amateur robotics movement, the goal for many in amateur robotics has been the development of plug-compatible robot modules, and we were no exception eight years ago in the Seattle Robotics Society. The topic comes up periodically in any robotics club, usually when someone says, "Say, we ought to have a standard robot for the club ..."

The discussion degenerates into religious arguments on the relative merits of various microcontrollers, about legs vs. wheels, or even (so help me) batteries vs. fuel cells, until somebody in exasperation points out that what is *really* needed is a way to interface commonly-used function blocks (which is the best we can expect to do because Gearheads are such a contentious lot). What goes on inside the blocks is then up to the individual cantankerous designer/builder.

The concept is simple: First, we decide what function blocks are necessary for building robots (this alone can take days of arguing), then we define interfaces between those function blocks.

ROBBI To The Rescue

ROBBI (ROBot Builder Interface) is a proposed standard I worked with in the early 90's that defined these blocks and the interfaces. Though a bit unwieldy for small robots (like Breadbot) because it uses 16- or 32-pin connectors, ROBBI still makes sense for medium and large robots, especially if you want an exceptionally easy-to-understand interface.

What function blocks are needed? A simple mobile robot might only need to run a couple of motors, as well as monitor some bumper contact switches, while a more complex robot could have devices as complicated as hydraulic operated legs, gyroscopes, and laser range finders. To be useful, a standard interface must allow for this wide range of device types, but still be simple enough to understand and apply.

To distinguish devices from robot subsystems, I'll call robot subsystems gadgets. Gadgets come in four flavors that correspond roughly to the first four device types: motor, sensor, communicator, and computer. Devices are always single class; a DC motor is an actuator, a video camera is a transducer, and a speech synthesizer is an annunciator, but gadgets can be composed of devices of several classes.

The class of a gadget is determined by a common-sense analysis of the primary function of the gadget. For example, a mobility base with two motors (actuators), optical encoder feedback (transducers), and a motor controller (driver, controller) would be considered to be a *motor gadget*; a vision subsystem consisting of a video camera (transducer) mounted on a motor-driven pan-tilt head (actuator) would be a *sensor gadget*.

A combination of gadgets of several classes to form a single subsystem is called a complex gadget. A subordinate robot is an example of a complex gadget. For this three-tier hierarchy (Robots, Gadgets, and Devices), there are three corresponding interface levels: Robot Level, Gadget Level, and Device Level.

Robot Level

Robot Level interfacing would involve things as sophisticated as speech recognition or perhaps running entire fleets of robots from a central computer. The information flowing through a Robot Level interface would have the character of task descriptions. These task descriptions specify goals, high-level commands such as "Go to the bedroom, find laundry basket, take basket to laundry room, wash clothes from laundry basket." These commands might be in a natural language, such as English, or may have some other more compact representation.

Gadget Level

Gadget Level interfacing involves moving command, control, and status information between robot subsystems. Gadget level communication would take place on a high-speed network; with all gadgets preferably sharing the same interface type. The information flowing through a

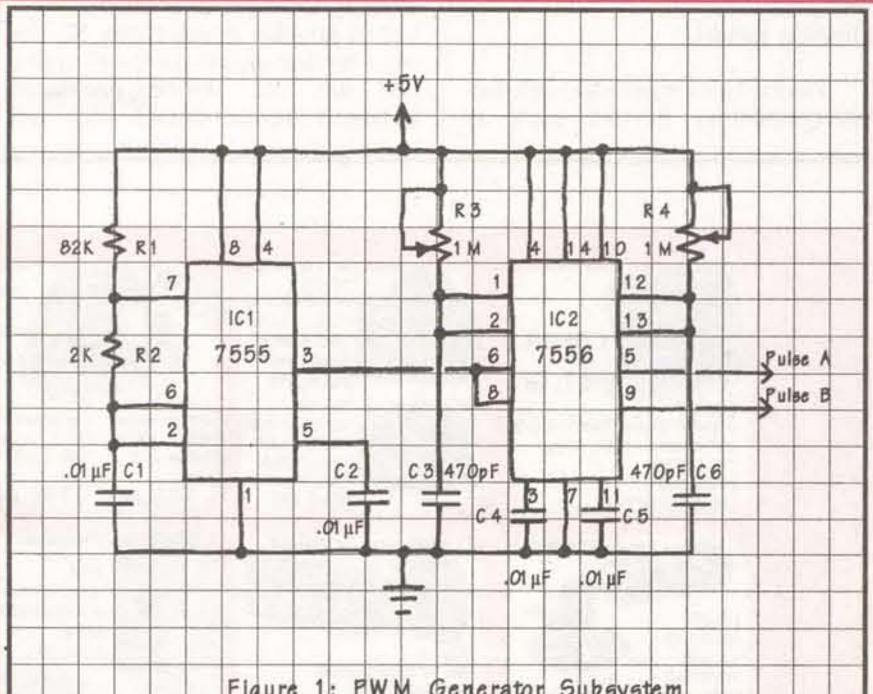


Figure 1: PWM Generator Subsystem

Gadget Level interface would have the character of action descriptions such as "Go forward two feet, take sonar readings, turn 45 degrees left, report bumper status, run scanner motor CCW at 50 RPM."

Device Level

Device Level interfacing involves interconnecting devices such as motors, relays, sonars, power drivers, bumper contacts, motor controllers, etc. Device Level interfaces are byte-oriented. While there are only five device classes (actuators, transducers, annunciators, drivers, and controllers), there are an enormous number of possible device types. No single interface would do for all types, but we can define interfaces between device classes that will cover most situations. This time, I'll define the classes of devices.

Actuators

Actuators are the muscles of a robot. Devices such as DC motors, solenoids, hydraulic cylinders, stepper motors, ducted-fan thrusters, and rocket engines are all actuators. Actuators typically require high current, high voltages, or both for operation; actuators are usually open loop control devices, so feedback is often used to close the loop to improve performance.

Annunciators

Annunciators are the expressive personality of a robot. Devices such as speech synthesizers, "talking head" displays, strobe lights, and status readouts are examples of annunciators. Annunciators are typically used by a robot to communicate with people. The nature of the communication ranges from entertainment to danger warnings.

Transducers

Transducers are the eyes, ears, and nose of a robot. Devices such as photocells, thermistors, force sensitive resistors, strain gauges, pressure transducers, battery voltage monitors, ultrasonic range finders, CCD video cameras, optical encoders, limit switches, and tachometers are all transducers. Transducers monitor physical quantities in the environment, as well as on board the robot. Transducer signals are often analog in nature.

Drivers

Hardware drivers are the heart of a robot (not to be confused with software drivers). They form the bridge between devices that interact with the environment (actuators, sensors, and annunciators) and devices that interact with other devices (controllers). Drivers perform the mostly analog functions of power supply, power switching, signal conditioning, and signal conversion. Power supply functions can include voltage/current regulation, over/under current/voltage protection, battery charging, DC/DC conversion, and power distribution. Power switching functions can include switching high current/voltage loads and PWM motor drive. Conditioning functions can include amplification, level shifting, debouncing, and filtering. Conversion functions can include Analog to Digital (A/D), Digital to Analog (D/A), Voltage to Freq. (V/F), Freq. to Voltage (F/V), Resolver to Digital (R/D), etc.

Controllers

Controllers are the brains of a robot, or at least the autonomous nervous system. Controllers bridge between higher and lower levels in the gadget hierarchy, decomposing complex actions into simpler actuator/sensor/annunciator command sequences. Controllers are generally high speed, general-purpose microprocessors or microcontrollers, but could also be logic state machines, digital signal processors (DSP), or user remote controls. Controller sig-

nals are exclusively digital.

Putting It All Together

Actuators and transducers interface with drivers, and drivers interface with controllers. Interfaces between controller devices and driver devices are called *channels*. Raw device interfaces may carry any combination of digital or analog signals, high or low level, but channels carry only properly conditioned digital TTL or HCT-level signals.

Motor Channels

The ROBBI Motor Channel allows simple interfacing to DC motors with device independence. One Motor Driver might use relays to control direction and a power transistor for PWM speed control of a 20 amp motor; another might use sophisticated MOSFET H-bridges for a 20 mA motor. With the ROBBI SMC, the same Motor Controller (MC) can be used for both. It is the division of the functions of control and drive that allows this to happen.

ROBBI Motor Channel interfaces come in Single Motor Channel (SMC) and Dual Motor Channel (DMC) varieties. The SMC uses a 16-pin ribbon connector (the "ROBBI-16" connector), while the DMC uses a 34-pin ribbon connector ("ROBBI-34"). The ROBBI SMC is comprised of eight signals: four outputs to give bidirectional control of a DC motor and optional brake, and four inputs to monitor speed, direction, and limit status.

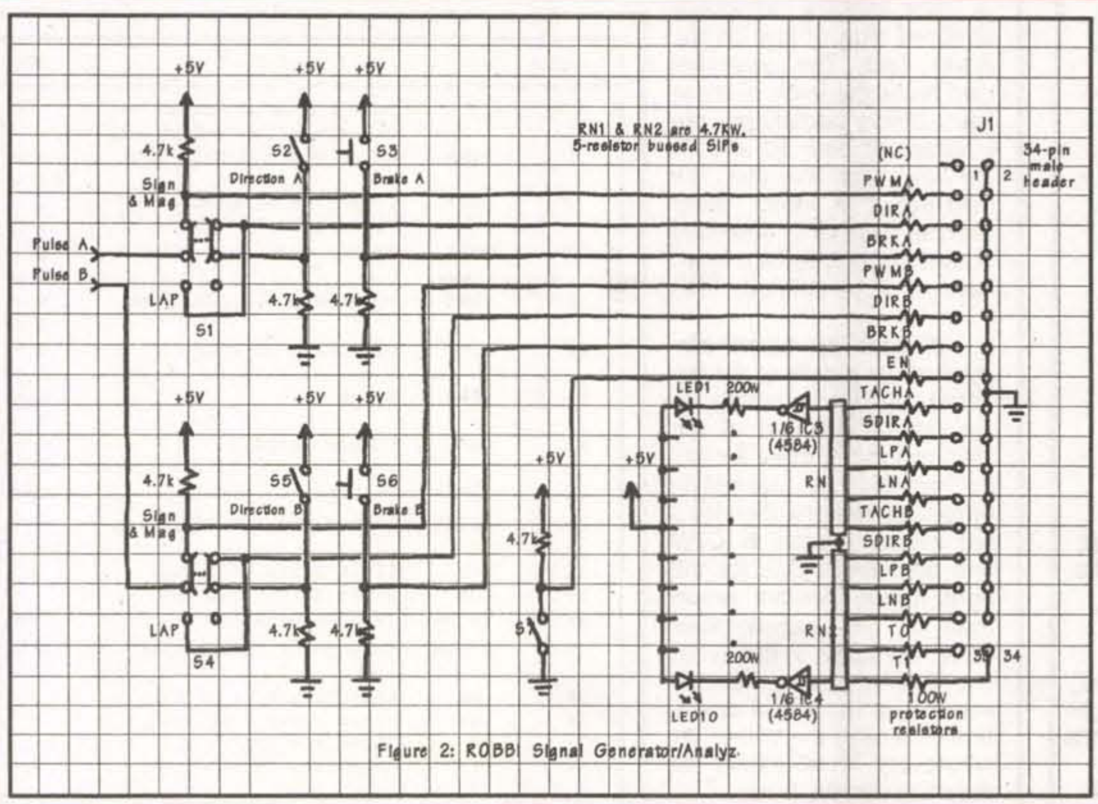


Figure 2: ROBBI Signal Generator/Analyz.

Table 1 gives the pin assignments for a ROBBI-34 DMC interface. The DMC is just two SMCs sharing the same connector with the addition of two new signals, T0 and T1, used to identify driver interface type.

Generic Motor Channel Signals

PWM. A pulse width modulation signal is used to control speed.

DIR. 1 for positive motion, 0 for negative.

EN. Enable = 0 selects default pin functions, Enable = 1 selects alternate pin functions. The alternate pin functions allow future enhancements, such as the ability to control stepper motors with a ROBBI Motor Channel interface. To ensure compatibility with future versions of ROBBI, when EN is brought high, the MD tristates TACH, SDIR, LP, and LN with the MC optionally pulling those corresponding lines high. Also, PWM, DIR, and BRK are isolated on MD from their corresponding MC pins and are pulled low on the Motor Driver.

BRK. This signal supports two different styles of braking: shunt and clutch. Shunt braking involves shorting the motor terminals together which slows the motor. Shunt braking occurs when the PWM and BRK signals are both low or both high. Clutch braking is active only when BRK is high, regardless of the state of PWM. This function is optional and can be used in addition to shunt braking. If no clutch brake is implemented on the motor controller (MC), this line should be tied to ground.

TACH. This signal is used to monitor motor shaft output speed. The speed is determined from TACH by dividing its pulse frequency by the number of pulses the tachometer generates per revolution. Optical, magneto, and Hall-Effect type tachometers naturally generate pulse outputs which can be used directly for TACH; tachometers that create analog outputs, say a voltage proportional to speed of rotation, may be used with suitable signal conditioning (i.e., voltage-to-frequency conversion). If a tachometer is not used, this line should be pulled high by MD.

SDIR. The Sensed Direction signal can be derived from quadrature decoding in a discrete encoder or from the voltage polarity of an analog tachometer. For quadrature decoding, this signal may lag a few pulse times behind the TACH signal.

LP, LN. These signals act as limit condition sense lines where one or the other — but not both — lines dropping low informs the controller that a limit of travel has been reached in the corresponding direction. If both signals are low simultaneously, the interpretation changes to that of an index or home position pulse. LP and LN will normally be held high by the motor driver. If MD doesn't implement limit and index functions, these lines shall be tied to +5V.

T0, T1. These signals allow a driver module with a ROBBI-34 interface to identify what type of driver it

is. These lines are individually strapped high or low on the driver card. The controller card reads the levels of these lines before initializing the interface. If both T0 and T1 are low, this indicates the interface is a motor driver channel (type 0) as described above. Other interface types have yet to be defined.

A note on terminology: Positive is defined for the above signals according to the natural function of the limit involved. If these are limits applied to tank-style propulsion motors, then for a left motor, positive is CCW and negative is CW; for the right motor, positive would then be CW and negative CCW. The rule is to pick what direction is positive for the actuator in its normal operation, reversing the wiring (or whatever) if necessary to maintain positive sense.

Pin #	Func	Description	Interpretation	Source
2-32	GND	Even # pins grounded		
1	--	(reserved for future exp.)		
3	PWMA	Pulse Width Modulation	0 = Motor OFF 1 = Motor ON	MC
5	DIRA	Direction of Motion	0 = Positive 1 = Negative	MC
7	BRKA	Brake	0 = Brake OFF 1 = Brake ON	MC
9	PWMB	Pulse Width Modulation	0 = Motor OFF 1 = Motor ON	MC
11	DIRB	Direction of Motion	0 = Positive 1 = Negative	MC
13	BRKB	Brake	0 = Brake OFF 1 = Brake ON	MC
15	EN=0	Enable default	0 = Def. funct. 1 = Alt. funct.	MC
17	TACHA	Tachometer Pulse A	PFM, freq. f_0*	MD
19	SDIRA	Sensed dir. of Motion	0 = Positive 1 = Negative	MD
21	LPA	Limit Sense, Pos DIR		MD
23	LNA	Limit Sense, Neg DIR		MD
25	TACHB	Tachometer Pulse B	PFM, freq. f_0*	MD
27	SDIRB	Sensed dir. of Motion	0 = Positive 1 = Negative	MD
29	LPB	Limit Sense, Pos DIR		MD
31	LNB	Limit Sense, Neg DIR		MD
33	T0	Interface Type bit 0		MD
34	T1	Interface Type bit 1		MD

MC = Motor Controller   MD = Motor Driver
* Rev/sec = f_0/(counts/rev)

Table 1: ROBBI DMC Signal Definitions

Why So Many Grounds?

With the first eight signals, most DC motors can be controlled. The rest of the lines available in the channel (except for the driver type bits) are ground lines. This may seem a waste, but the ground lines are important.

Robots are electrically noisy creatures. Arcing commutator brushes, high current circuits, poor shielding, and layout make the difference between robots that work flawlessly and robots that don't work at all. Fortunately, we can do a great deal about shielding and layout.

There are two main types of electrical interference. One is Capacitively coupled, the other is Inductively coupled. For inductive coupling, reduction of loop area is the name of the game. A ground between every signal in a ROBBI channel ensures that each signal has the minimum possible loop area to pick up inductively coupled noise.

The ground lines also provide a modest amount of electrostatic shielding between signals. Whenever two wires run close to each other, they form a capacitance through which signals can be capacitively coupled. With a ground between two signal lines, the capacitors formed are between each signal and ground, rather than from signal to signal. This substantially reduces crosstalk.

Finally, having a dedicated ground for each signal allows the return current for each signal to flow through that ground. In a way, this is a restatement of the reduction-in-loop-area principle, but this also has the effect of reducing differences in ground potential between the two ends of the cable.

Ground potential differences are more commonly known as the dreaded Ground Loop. Note that a loop in a ground does not a ground loop make; a ground loop is specifically a current loop created by differences in ground potential existing in the circuit. The goal is to reduce ground potential differences as much as possible. One way to do that is to provide dedicated grounds for every signal.

An excellent introduction to the causes and cures of electromagnetic interference can be found in Intel Applications Note AP-125 "Designing Microcontroller Systems for Electrically Noisy Environments," and Article Reprint AR-102, "PC Layout Techniques for Minimizing Noise." I recommend both articles.

A ROBBI-34 Exerciser

The ROBBI-34 Exerciser presented here is useful both as a piece of test equipment and as a tool for exploring the mechanical behavior of your robot. The Exerciser allows you to manually control all of the signals needed to make two motors run under varying speed, direction and brake settings, as well as observe all tachometer, sensed direction, and limit conditions the DMD board provides.

You can do this before writing any motor control software for your Dual Motor Controller, indeed before you've even built the controller. Thus, you can check for correct drive motor wiring polarity before your controller errantly sends your robot careening in an unexpected direction.

How The Circuit Works

The Pulse Width Modulation (PWM) generator (Figure 1) is the heart of the Exerciser. With the values given for R1, R2, and C1, IC1 provides a time base of two kHz to trigger both timers of IC2. The timers of IC2 are wired in the monostable or one-shot mode so that each trigger pulse from IC1 initiates a single output pulse from each timer. The durations of these pulse outputs – Pulse A and Pulse B – are controlled by R3 & C3, and R4 & C6, respectively.

You can use most any one megohm linear taper potentiometers for R3 and R4, but I like to use linear slide pots for this purpose rather than ordinary rotary pots because the linear pots give immediate visual and tactile feedback on the duty cycles of the Pulse A and Pulse B outputs.

The rest of the Exerciser circuit can be broken down into two sections, the switch control section (left half of Figure 2) and the feedback display section (lower right of Figure 2).

Please note that my contact information is now different. If you have suggestions, questions, or comments about amateur robotics topics, you can now reach me at:

Robert Nansel
Box 228
Ambridge, PA 15003

The E-Mail address is the same:
E-Mail: bnansel@nauticom.net

In the switch control section, when S1 is set to the "Sign & Magnitude" position, it routes the Pulse A and Direction A signals to the PWMA and DIRA output pins on J1; here S2 determines what the level of the DIRA output pin will be. However, when S1 is set to the "LAP" (Locked Anti-Phase) position, S2 is disconnected, PWMA is held high, and Pulse A is routed to DIRA instead of PWMA. S4 and S5 work the same way for PWMB and DIRB.

S&M vs. LAP

As mentioned in previous columns, LAP is an alternate way to control motor speed and direction. With PWM held high continuously, DIR causes motor current to attempt to change direction at the two kHz time base. Motors cannot mechanically respond to such rapid current reversals, reacting instead to the average direction of the current.

When DIR outputs a 50% duty cycle waveform, the motor is motionless; higher than 50% the motor turns forward, lower than 50% the motor turns backward. The speed will be proportional to how far from 50% duty cycle DIRA goes.

Why do this? For many applications, Sign & Magnitude control of motors works fine, but from a control perspective, LAP offers the advantage that you can smoothly control a motor through zero speed.

With Sign & Magnitude control, motors behave non-linearly for low speeds. Some gearmotors I've experimented with refuse to turn, even with no load applied, at PWM duty cycles less than 40%; with LAP you do not have this problem.

LAP can use more power than Sign & Magnitude control if the PWM frequency isn't matched to the armature inductance of the motor, but this usually isn't a real problem. (The relay-type H-bridges shown earlier in this series can <u>not</u> use LAP control.)

The rest of the switch control section consists of S3 and S6, which provide logic levels for BRKA and BRKB, respectively, and S7, the interface enable switch. Both BRKA and BRKB override their respective PWM and DIR signals. If the DMD board is capable of it, the motor leads are shorted together to dynamically brake the motor; electromagnet-type clutch brakes are also activated by these signals.

The feedback display section allows simple line level monitoring of TACH, SDIR, LP, and LN signals for A and B motor channels. IC3 and IC4 are Hex Schmitt-Trigger inverter/buffers driving low current LEDs.

RN1 and RN2 provide pulldowns so the inputs of IC3 and IC4 won't float and thus be damaged if no DMD is plugged into J1. The 100 ohm series resistors provide protection against overvoltages and short circuits on the DMD side.

The TACH signals are active low pulse trains, so the brightness of their indicators is inversely proportional to pulse frequencies. I prefer this approach because each LED then shows the true input line level.

You could, however, use the two spare inverters to add another inversion to each of these signals so brightness would then be proportional to the TACH pulse frequencies. Some other improvements for the circuit might be to add LED indicators for the output signals, digital frequency counter displays for the TACH signals, line floating indicators, etc.

If you try any of these variations, I'd be interested to see how they work. The circuit as it stands is simple and inexpensive and should provide a valuable tool for your robotics workbench.

Now, Where Is That Box ...

By the time you read this, I should have my workshop unpacked and functioning smoothly again, so I can get back to the motor H-bridge series (and maybe even get back on track with the I2C code ...). Until then, don't forget to enter the Second Lonely Gearhead Contest. May 1st is the deadline. **NV**

Got something to sell?

Try the classifieds!!

TYPE or PRINT your **ELECTRONICALLY RELATED** ad copy **CLEARLY (not all caps)** on a separate piece of paper. Spell out words when submitting handwritten copy. Calculate the number of words and multiply it by the appropriate rate (see RATE PER WORD section). Include any charges for **bold** and/or CAPPED words, any artwork costs that would be applicable, and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see below). If no classification is indicated, it will be placed in Misc. Electronics or wherever we deem most suitable. **Enclose your name, address, phone number, and *Nuts & Volts* account number from your mailing label** (if available) for identification purposes. Include full payment — **CLASSIFIEDS RUN ON A PRE-PAID BASIS ONLY —** and mail your completed order to:
NUTS & VOLTS MAGAZINE, 430 Princeland Ct., Corona, CA 92879.

RATE PER WORD

The ad rate for **current PAID subscribers** is **60¢** per word. All others pay **$1.20** per word. There is a **$9.00 minimum** charge per ad per insertion.

WORDS IN BOLD AND/OR ALL CAPS

Words to be set in **bold** or CAPS are each 10¢ extra PER WORD. **BOLD CAPS** are 20¢ extra per word. The first two words of each ad are bold capped at no charge. Indicate bold words by underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are NOT charged as all cap words. Use a two-letter abbreviation for states.

PHOTOS, DRAWINGS, AND BOXES

A photo or drawing may be run at the top of your classified ad for an additional **$10.00** (1" depth max.) for camera-ready art. No wording is allowed in this area. To **BOX** your ad, include an additional **$50.00** for copy-only ads, or **$75.00** for ads with art or photos.

FAXING IN AD COPY

You may fax in ad copy or changes before the closing date (5:00pm on the **5th**) at 909-371-3052 using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL OR FAX BACK VERIFICATION OR QUOTES OF FAXED-IN ADS.** For verification of faxed-in ads, please call 909-371-8497.

DEADLINE

Prepaid ads received by 5:00pm on the **closing date (5th of the month)** will appear in the following month's issue. Ads postmarked through the **5th**, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 5th. Cancellations and changes must be submitted in writing.

IMPORTANT INFORMATION

All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in *Nuts & Volts* is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 60¢ rate only through their subscription expiration date. **NO REFUNDS**. Credit only. No credit for typesetting errors will be issued unless you *clearly* print or type your ad copy.

Choose a category for your ad from the classifications listed below.

10. Ham Gear For Sale
20. Ham Gear Wanted
30. CB/Scanners
40. Music & Accessories
50. Computer Hardware
60. Computer Software
70. Computer Equipment Wanted
80. Test Equipment
85. Security
90. Satellite Equipment
95. Military Surplus Electronics
100. Audio/Video/Lasers
110. Cable TV
115. Telephone/Fax
120. Components
125. Microcontrollers
130. Antique Electronics
135. Aviation Electronics
140. Publications
145. Robotics
150. Plans/Kits/Schematics
155. Manuals/Schematics Wanted
160. Misc. Electronics For Sale
170. Misc. Electronics Wanted
175. BBS & Online Services
180. Education
190. Business Opportunities
200. Repairs/Service

ADVERTISER INDEX

Find what you need *FAST* by Product or Category



HIGHEND EQUIPMENT 203-744-4111. OK INDUSTRIES DEMO BLOWOUT. If it is not listed just give us a call, chances are we have it! **SOLDER STATIONS**: total rework, forced convection, hot air. MTR5000 (retail $4,595) sell $1,700; MTR4000 (retail $3,995) sell $1,400; MTR3001 (retail $2,495) sell $900; BTR2001 (retail $1,595) sell $500; FCR2001 (retail $1,850) sell $700; BTR1000 (retail $825) sell $300; SMT1160 (retail $995) sell $400; SA2000 (retail $395) sell $140; SA1000 (retail $295) sell $100; SA500 (retail $145) sell $50. **PUR-AIR**: Fume exactors. EP101 (retail $1,695) sell $200; EP051 (retail $595) sell $100. **JEM**: Batch ovens JEM310 (retail $7,995) sell $2,500; JEM210 (retail $4,995) sell $1,000. **PICK & PLACE**: Chip placers, vacuum pencils, fluid dispensers. SMT8501 (retail $4,595) sell $1,500; SMT880 (retail $2,200) sell $500; FD1000 (retail $495) sell $150; VP100 (retail $395) sell $100. **BOARD ETCHER**: SSP-75A (retail $995) sell $300. **ALWAYS BUYING: VIDEO, RADIO, PHONE SYSTEMS, COMPUTERS, STEREO, AND BROADCAST EQUIPMENT.**

WANTED: VIDEOJET EQUIPMENT. Buying complete cabinets, boards & miscellaneous parts. Call: 1-800-747-7450 ask for Kurt.

MISCELLANEOUS ELECTRONICS WANTED

WESTERN ELECTRIC wanted: 1920s-1960s. Amplifiers, mixers, pre-amps, speakers, tubes, etc. FREE OFFER 1-800-251-5454.

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

WANTED: TUBES, radios, transmitters, receivers, gyros, bearings, connectors, relays, lamps, synchros. Hyness Company, 709B Delair Road, Monroe Twp., NJ 08831. Phone: 609-395-1116, FAX 609-395-1117.

Continued from page 59

WANTED: NAMCO LASERNETS. Models: LN 110-30001, LN 110-40001 & LN 110-60001 & misc. parts. Call: 1-800-747-7450 ask for Kurt.

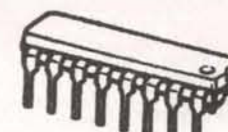
SECRETS OF RF CIRCUIT DESIGN From Joseph Carr, one of today's most respected electronics authors, comes this pragmatic, intermediate-level guide to designing, building, and testing all types of radio frequency circuits. Filled with functional projects that demonstrate the principles of RF circuits. Only $29.95! **10% discount to *Nuts & Volts* subscribers.** Call **1-800-783-4624** to order using Visa or MasterCard.

FREE FLYER on DBS, cable TV, phones, credit cards, schematics, health items. Bill 1-800-879-9657.

HIGH QUALITY TOOLS AND STAINLESS STEEL HARDWARE. European and American screwdrivers, nutdrivers, pliers, hex-keys, balldrivers, and more! Wiha, Bondhus, and Knipex. Stainless cap screws, machine screws, nuts, washers, U-bolts, and eyes. Free catalog. Robert Mink Import-Export, Box 6437V, Fair Haven, NJ 07704. Telephone or fax 732-758-8388. E-Mail: w2tv@compuserve.com

TUBES GALORE: Send SASE for new list AB; telegraph instruments (list TG); test equipment (list TE). Special 3-level rotary switch, 20 contacts per level, $15. Amphenol and Cinch-Jones plugs, sockets, and connectors. Wanted: 4-pin amphenol plugs. Typetronics, PO Box 8873, Ft. Lauderdale, FL 33310-8873. Fred Schmidt N4TT, 954-583-1340, fax 954-583-0777.

PC CABLES: http://www.pccables.com connectors, RS232, IDC, SVHS, ribbon cable, DB9, DB15, loopback, null modem, jumpers, SCSI, screws, rails. Secure online catalog, ordering, browsing. 954-418-0817.



WANTED: EXCESS ELECTRONIC COMPONENTS, BOARD-LEVEL COMPONENTS; MILITARY COMPONENTS; ICs, MEMORY, TRANSISTORS, DIODES, CAPS, RELAYS, ETC. CALL LPS 562-439-2453 FAX 562-439-0453.

CASH PAID FOR ICs. Military or commercial integrated circuits, transistors, diodes, any semiconductors. **ELECTRONIC SURPLUS, INC.**, 5363 Broadway, Cleveland, OH 44127. 216-441-8500 or fax 216-441-8503, since 1946. www.electronicsurplus.com

WANTED: AVIONICS test equipment, IFR, 600A, 401L, others, Collins, King, Sperry, North Atlantic, Litton INUs LTN series, rate and tilt tables, air data test sets, 941-625-3222 P, 941-625-0494 F, E-Mail: avionics@afcon.net

WANTED: UNITEK WELDING EQUIPMENT. Buying power supplies, welding heads, etc. Call 608-831-3443.

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

WANTED: X-BAND radar equipment. Military, civilian, working or not, parts, TMs, etc. Box 10215, Pittsburgh, PA 15232.

HIGHEST PRICES PAID: I will pay the following prices for Western Electric tubes: 211A/D/E new $300, used $175; 212A/D/E new $750, used $275; 274A/B (engraved base) new $250, used $200; 300B (engraved base) used $550; 422A new $50, used $25; 437A new $50, used $25; and many more. Also buying Western Electric, and other audio tube and equipment literature. Call or send us your list. Toll free tel/fax: 1-888-715-8823. Don Singerhouse/Singerhouse Sound, LLC, PO Box 321, New Richmond, WI 54017. E-Mail: singtube@frontiernet.net

WANTED: BALANCING machines & vibration analyzing equipment manufactured by the following: Spectral Dynamics, Hofmann, Bentley Nevada, Schenck, IRD Mechanalysis, Gishott. Contact Mike Park at E.T. Balancing, 12823 Athens Way, Los Angeles, CA 90061. 310-538-9738, FAX: 310-538-8273.

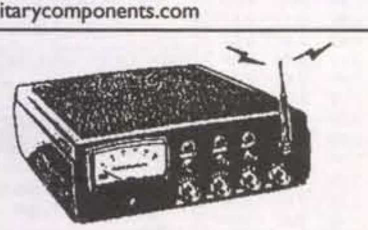
BBS & ONLINE SERVICES

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

EDUCATION

BUSINESS OPPORTUNITIES

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com



COUNTER-SURVEILLANCE=$250 HR! Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn **$250 HR** in the fascinating field of COUNTER-SURVEILLANCE! For FREE catalog call: **1-800-732-5000**.

REPAIRS — SERVICES

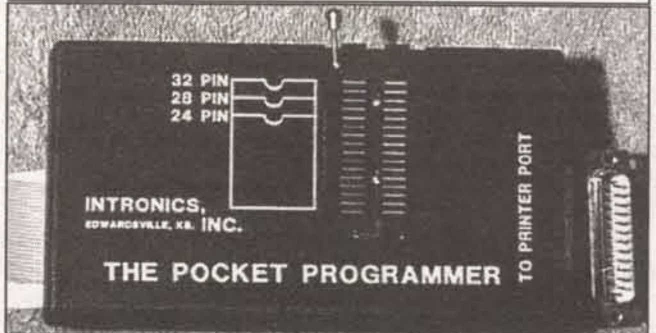
PC BOARD ASSEMBLY. Thru hole only. Small or large quantities OK. Call Network Sales. 616-683-0500.

PICS, GALS READ if you've lost your masters. Programming service available. Call for info. Network Sales, 616-683-0500.

PC BOARDS REPAIRED. Prices start at $5. Minimum 5 of one type. Network Sales, 616-683-0500.

PRINTED CIRCUIT design by professional with 30+ years: conventional, multilayer, downhole, fine line. Prototype and production fabrication. Reverse engineer existing 2-layer board. Toll free 877-236-3223. www.circuit-applied-tech.com

The Pocket Programmer

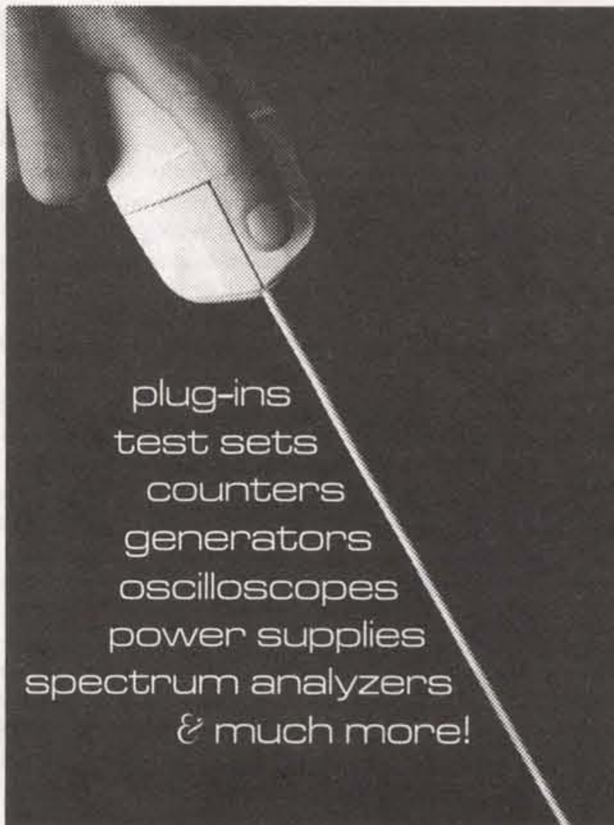


The portable programmer that uses the printer port of your PC instead of a internal card. Easy to use software that programs E(E)prom, Flash & Dallas Ram. 27(C)/28(C)/28F/ 29F/29CXXXX & 25XX series from 16K to 8 Megabit with a 32 pin socket. Adapters available for Pic, MCU's 874X, 875X, 40-Pin X 16 & Serial Eprom's, PLCC, 5-Gang, 82/74 Prom's and Eprom Emulator to 32K X 8.

Only $129.95

Same Name, Address & Phone Number for 16 Years.... Now isn't that Amazing ?

Intronics, Inc.
Box 13723 / 612 Newton St.
Edwardsville, KS 66113 **Add $5.00 COD**
Tel. (913) 422-2094 **Add $4.00 Shipping**
Fax (913) 441-1623 Visa / Master Charge / Amex



www.levylatham.com

PRIVATE MARKETERS OF U.S. GOVERNMENT MILITARY SURPLUS ASSETS

Write in 45 on Reader Service Card.

CABLE CONVERTER REPAIR: Quality repair service for all name brands. If you're tired of the runaround you're getting from the company you purchased it from, or they're out of business. Give us a call for fast and courteous service, Have model and problem ready. Sorry no box, chip, or IL repairs. **Highview Engineering 815-245-3735** or E-Mail: HIGHENG1@AOL.COM ask for George.

MAGICIAN IS available to solve your RF problem. Invest in your RF future, learn the practical side of RF circuit design in my laboratory. I will teach you how-to-do it with up-to-date components. Minaret Radio, John Horvath ph: 909-421-3983.

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

WELD ALUMINUM WITH PROPANE! EZ, INEXPENSIVE, STRONG. DETAILS: WEEKS, 36 CAROLINA ST., TAYLORS, SC 29687. 1-800-547-WELD(9353) FAX 864-244-6349. http://www.durafix.com

WE REPAIR and refurbish CBTV converters, all models, reasonal, 6-month warranty. Also sale converter parts and remote. 405-692-4982.

(E)EPROM PROGRAMMING done quickly and economically. One day turn around typical. Simple copy $3 per device. Also prototyping, design, and consulting services available. Call or send SASE to: **Luzer Electronics, 4023 North Bayberry, Wichita, KS 67226. 316-687-2127, FAX 316-687-3103.**

DREAMCAST MOD chips, 6 wire model, $38 each. Complete color instructions. Also Playstation mod chips. New "Auto Dino" mode program. Works with all models up to 900X. Color instructions. Seven wire hook-up, $5 each. 10% discount for 10 or more, mix and match kits. Kits do not come with wires. Call 703-764-5118 to place an order.

TIMELESS PRODUCTS

The Best Prices and Service • In Business over 15 years!

Phone 218-346-6660 Fax 218-346-6664

CABLE TV CONVERTERS

WILL NOT DECODE

New! "TP 125 V"
128 Channel Converter with Volume

Special Prices for TP1550PC Call for Details

Panasonic still available!

- REFURBISHED CONVERTERS ALSO AVAILABLE •
- QUALITY REPAIR DEPARTMENT FOR ALL YOUR TUNER REPAIRS •
- REMOTES AVAILABLE FOR MOST CABLE BOXES •

DEALERS ONLY • GREAT QUANTITY PRICES • NO DECODER SALES

Write in 46 on Reader Service Card.

Continued from page 62

When Windows 95/98 starts up it automatically launches a number of programs. While most programs come from the StartUp folder, Windows also looks in six other locations for files that should be launched at start-up. Startup Cop helps you handle problems with programs that are automatically launched at start-up by listing them and letting you disable, enable, or delete them. You can save the list of programs that are currently enabled or disabled as a profile that can be restored at a later time Best of all, it's free!

hotfiles.zdnet.com/cgi-bin/texis/swlib/hotfiles/info.html?fcode=000YKL

Hey, it's my E-Mail message — but in Portuguese. Nope, I don't know Portuguese, but I know how to use AltaVista's Translation page. I leaned about this feature after receiving mail from a reader in Brazil. Just cut and paste some text into the box, choose a language (English to Spanish, French, Italian, German, or Portuguese, or the other way around) and in seconds, it's translated.

babelfish.altavista.digital.com/cgi-bin/translate

Looking for hard-to-find equipment manuals? Visit the PlanetTest.com Virtual Store where you'll find the best online source for test equipment manuals. Hewlett Packard, Tektronix, Fluke, General Radio, and Wavetek are just a few of the many manufacturer's manuals listed. Plus, search the largest online auction of test & measurement equipment at PlanetTest.com for incredible savings. Excellent source for manuals.

www.PlanetTest.com

MAILBAG

Hello TJ:

At first, I thought I'd add to your list of IC numbering prefixes using my handy-dandy Newark Electronics catalog. In the back, they have 34 pages titled "Manufacturer Series/Part Number Index" that's a more-thorough version of what you posted. Newark's listing covers all types of electronic components — including integrated circuits. Unfortunately, the list isn't exhaustive, for it does not contain the elusive "NJM" — the prefix of the device in question. Nonetheless, it's very handy; readers can get a printed or CD-ROM version of the Newark catalog through their website (http://www.newark.com) or by calling 800-463-9275.

Dean Huster
Electronics Instructor
Poplar Bluff Technical Career Center
Poplar Bluff, MO

Response:

Thanks for the great input. I thought Newark dropped that section, but it appears to be alive and well. Also, on the front cover of the Jameco catalog, you'll find logos of the various manufacturers; if you kept your old issues (which I didn't), you'll find logos for long-gone vendors. As to the mysterious NJM prefix, I found who sponsors it:

NJR Corporation
440 East Middlefield Rd.
Mountain View, CA 94043

How'd I find it? Using Prefix Finder **www.hitex.com/chipdir/prefix/index.htm**. Haven't had time to verify that, I'm at Carnival as I write this, so I leave that up to you. Thanks again for the input!

TJ Byers
Q & A Editor

Q & A or Tech Forum?

If you have questions about any aspect of electronics, from circuit design to theory explanations, or just need to be pointed in the right direction to get that project started (or finished), *WE CAN HELP!*

The Tech Forum will get your question looked at by *thousands* of readers. Sometimes several answers might be published giving different approaches to solving your problem.

The **Q & A** column generally offers a quicker response from noted electronics author TJ Byers. Follow-up or spin-off questions and/or discussions might also appear in this column.

Send to:
Nuts & Volts Magazine
430 Princeland Court
Corona, CA 91719
Fax **909-371-3052**
E-Mail:
tjbyers@aol.com
forum@nutsvolts.com

Events CALENDAR

Continued from page 37

JULY 15

TX - SHERMAN/DENISON - Hamfest. Wilmer O. Kinsey WB5DCU, 903-893-5872. E-Mail: wb5dcu@gte.net
TX - TEXAS CITY - Hamfest. Tidelands ARS, Joe Wileman AA5OP, 409-945-6794. E-Mail: aa5op@aol.com

JULY 16

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html
MO - WASHINGTON - Hamfest. Zero Beaters ARC, Keith Wilson K0ZH, 636-629-2264. E-Mail: jwpubl@fidnet.com Web: http://zbarc.usmo.com/
NJ - AUGUSTA - Hamfest. Sussex County Fairgrounds, Plains Rd. Talk-in: 147.90/30. Sussex County ARC, Dan Carter N2ERH, 973-948-6999. E-Mail: n2erh@email.com Web: http://www.scarcnj.org
PA - KIMBERTON - Hamfest. Mid-Atlantic ARC, Bill Owen W3KRB, 610-325-3995. E-Mail: gem@op.net Web: http://www.marc.org/hamfest.html

JULY 21-22

FL - MILTON - Hamfest. Santa Rosa County Auditorium. Fri: 5pm-9pm, Sat: 8am-2pm. FCC Exams. Talk-in: 146.70. Milton ARC, Bill Couch W4VY, 850-623-0592. E-Mail: billcouch@sprintmail.com Web: http://home.att.net/~k4ozl/marc.htm

JULY 22

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665
OH - CINCINNATI - Hamfest. Diamond Oaks Development Campus, 6375 Harrison Ave. 7am-2pm. VE Exams. Talk-in: 146.67 and 146.925. OH-KY-IN ARS, Gene McCoy N8KOJ, 513-541-6935. E-Mail: n8koj@arrl.net Web: http://www.qsl.net/k8sch

JULY 23

IL - SUGAR GROVE - Hamfest. Waubonsee Community College, Rt. 47 Harter Rd. VEC Exams. Talk-in: 147.210 (+600) PL 103.5/107.2. Fox River Radio League, Maurice Schietecatte W9CEO, 815-786-2860. E-Mail: w9ceo@arrl.net Web: http://www.frrl.org/hamfest.html

JULY 28-29

OK - OKLAHOMA CITY - State Convention. OK State Fair Park (Hobbies, Arts & Craft Bldg.). Fri: 5-8pm, Sat: 8am-5pm. Talk-in: 146.82. Central OK Radio Amateurs, Harold Miller KB1ZQ, 405-672-7735 or 405-650-9963. E-Mail: n1lpn@swbell.net Web: http://www.geocities.com/heartland/7332
TX - AUSTIN - Convention. Austin ARC, Austin Repeater Group, Texas VHF-FM Society, Joe Makeever W5HS, 512-345-0800

JULY 28-29-30

AZ - FLAGSTAFF - State Convention. Ft. Tuthill. Fri: 12pm-5pm, Sat: 9am-5pm, Sun: 9am-2pm. VE Testing. Talk-in: 146.980 MHz with 100.0 Hz PL Tone. ARCA, Norm Martin K7OLD, 520-297-9562. E-Mail: norm@hamsrus.com Web: http://www.hamsrus.com/tuthill.html
CANADA - BC - VANCOUVER - Pacific Northwest DX Convention. BC DX Club & Fraser DX Club, Dave Johnson VE7VR, 604-438-8715. E-Mail: ve7vr@rac.ca Web: http://www.bcdxc.org

JULY 30

MD - TIMONIUM - Hamfest. Timonium Fairgrounds. Talk-in: 147.03+ and 224.96-. BRATS, Mayer Zimmerman W3GXK, 410-461-0086.E-Mail: w3gxk@arrl.net Web: http://www.smart.net/~brats
OH - RANDOLPH - Hamfest. Portage ARC, Joanne Solak KJ3O, 330-274-8240. E-Mail: ljsolak@apk.net Web: http://parc.portage.oh.us

AUGUST 2000

AUGUST 5

NM - ROSWELL - Hamfest. Pecos Valley ARC, Vernetta Verasso KC5WKA, 505-627-7777. E-Mail: kc5wka@dfn.com Web: http://www.pvarc.com
OH - COLUMBUS - Hamfest. Voice of Aladdin ARC, James Morton KB8KPJ, 614-846-7790. E-Mail: kb8kpj@cs.com

AUGUST 6

IN - ANGOLA - Hamfest. Land of Lakes, Bill Brown WD9DSN, 219-475-5897. E-Mail: sharon.l.brown@gte.net
VA - BERRYVILLE - Hamfest. Clarke County Ruritan Fairgrounds. VE Exams. Talk-in: 146.82-. Shenandoah Valley ARC, Irvin Barb W4DHU, 540-955-1745. E-Mail: ibarb@visuallink.com Web: http://www.vvalley.com/svarc/hamfest

AUGUST 12

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
IL - QUINCY - Hamfest. Eagles Alps Grounds, 3737 N. 5th St. 8am-2pm. VEC Testing. Talk-in: 147.63/147.03. Western IL ARC, Jim Funk N9JF, 217-336-4191. E-Mail: jfunk@adams.net Web: http://www.qsl.net/w9awe
WV - HUNTINGTON - Hamfest. Tri-State ARA, Dwight D. Smith, Sr. WB8JPJ, 304-522-7865. E-Mail: wb8jpj@home.com

AUGUST 13

IA - AMANA - Hamfest. Amana Outdoor Convention Center. VE Exams. Talk-in: 146.745/.145 and 146.520. Cedar Valley ARC, Chuck Bassett N0UTS, 319-378-0448. E-Mail: n0uts@rf.org Web: http://cvarc.rf.org
IN - GREENTOWN - Hamfest. Greentown Lions Club Fairgrounds. Kokomo & Grant County ARCs, L.B. (Nick) Nickerson KA6NQW, 765-668-4814. E-Mail: ka6nqwnick@netusa1.net Web: http://www.netusa1.net/~ka6nqwnick/hamfest.htmll
MI - JACKSON - Hamfest. Cascade ARS, Dennis Byrne KC8IJZ, 517-522-4058 or 517-796-6966. E-Mail: byrneda@voyager.net
MN - ST. JOSEPH - Hamfest. St. Cloud ARC, Linden Scott Hall KA0DAQ, 320-252-4498. E-Mail: lscotth@aol.com Web: http://www.w0sv.org/hamfest.html
NJ - BAYVILLE - Hamfest. Bayville Fire House, Rt. 9. VE Testing. Talk-in: 146.910 out, 146.310 in, PL 127.3. Jersey Shore ARS, Bob Murdock WX2NJ, 732-269-6379. E-Mail: jsarsfest@aol.com Web: http://members.aol.com/jsarsfest/jsarsfest.html
NY - DEPEW - Hamfest. Hearthstone Manor, 333 Dick Rd. VE Testing. Lancaster ARC, Luke Calianno N2GDU, 716-634-4667 or 716-683-8880. E-Mail: lcalianno@freewweb.com Web: http://hamgate1.sunyerie.edu/~larc

AUGUST 18-19-20

CANADA - BC - PRINCE GEORGE - Hamfest. Prince George ARC, Keith Powell VE7GDH, E-Mail: ve7gdh@rac.ca Web: http://www.pghamfest.dhs.org/

AUGUST 19

WA - LONGVIEW - Hamfest. Cowlitz County Expo Center. 9am-1pm. Talk-in: 147.26+. Lower Columbia ARA, Bob Morehouse KB7ADO, 360-425-6076. E-Mail: kb7ado@aol.com Web: http://www.qsl.net/nc7p/swapmeet.htm

AUGUST 20

IN - LAFAYETTE - Hamfest. Tippecanoe ARA, Bob Martin W9YE, 765-423-1035
KY - LEXINGTON - Hamfest. National Guard Armory, adjacent to Lexington airport. 8am-4pm. VE sessions. Talk-in 146.760-. Bluegrass ARS, John Barnes KS4GL, 606-253-1178. E-Mail: KS4GL@juno.com Web: http://www.qsl.net/k4kjg
MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

AUGUST 25-26-27

MA - BOXBOROUGH - Convention. Holiday Inn Conference Center. Tony Penta W1ABC, 617-248-6996 or 978-887-8887. E-Mail: w1abc@arrl.net Web: http://www.boxboro.org

AUGUST 27

IL - DANVILLE - Hamfest. Vermilion County ARA, Gary Denison KA9SKS, 217-759-7389. E-Mail: gdenison@danville.net
KS - SALINA - State Convention. Central KS ARC, Ron Tremblay WA0PSF, 785-827-8149. E-Mail: tremblay@midusa.net Web: http://www.qsl.net/w0cy
NY - YONKERS - Hamfest. Yonkers ARC, John Costa WB2AUL, 914-969-6548. E-Mail: wb2aul@aol.com
PA - NEW KENSINGTON - Hamfest. Skyview Radio Society, Robert Livrone N3WAV, 724-339-9607. E-Mail: n3wav@arrl.net

SEPTEMBER 2000

SEPTEMBER 8-9-10

FL - MELBOURNE - Hamfest. Melbourne Auditorium. Platinum Coast ARS, Tim Madden KI4TG, 407-724-9339. E-Mail: ki4tg@hotmail.com

SEPTEMBER 9

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
IN - SPENCER - Hamfest. Owen County ARA, Kathryn Smith K9INU, 812-829-2140
KY - LOUISVILLE - State Convention. Greater Louisville Hamfest Assn., Herbert Rowe W4WQD, 812-294-4905. E-Mail: wd4ixl@juno.com Web: http://www.thepoint.net/~glha/

Continued from page 28

back, the audio speeds up and slows down when I move the pentometer in the other direction.

Is this normal for all digital-to-audio chips? Is there audio output at the chip when I'm way beyond that clock frequency I recorded at?

What is the osc. frequency limits of the clock for voice communication?

You didn't specify which chip you were using, but chips like the ISD25120 *can* be sped up or slowed down by adjusting the oscillator frequency.

You can't count on varying the oscillator more than the allowance on the data sheet but, in reality, you will get away with a 10% to 20% variation easily.

Remember once you are operating an IC outside of the manufacturer's specification, all bets are off. Depending on how the digital-to-analog converter on the IC is designed and buffered, there might, in fact, be output down to very low oscillator frequencies. But once again, you can't count on it to work from chip to chip because you are so far outside the specifications.

If you want a circuit designed to adjust voices from James Earl Jones to Minnie Mouse then how about a small firmware/microcontroller/hardware project with an A/D, a PIC controller, some memory, a DAC and an audio amp IC?

Record the sound with the A/D and let the PIC controller play it back through the DAC all the way down to 1Hz if you so desire. I've seen this done in a small voice recorder and it worked great.

Robert Miller
Trenton, NJ

ANSWER TO #3006 - MAR. 2000

*What are *.gid files.*

The file extension *.GID is used by Windows as part of the HELP section of various programs. (Not every program uses a *.GID file, though.) The information contained in the *.GID file is what you would see if you clicked on HELP, then HELP TOPICS and then clicked on the CONTENTS tab.

The "links" you see under the CONTENTS tab are contained in this *.GID file. The *.GID files also contain information for the locations of actual help files. For instance, when you click HELP > HELP TOPICS > CONTENTS you now have links displayed to the actual help file contents.

When you double click one of these links and it opens a second window, you are actually opening another file. The *.GID is just an index of the help information. The file name and location of the *.GID usually can tip you off to which program it is associated with.

If you want to play with one of these files COPY it (DO NOT move or edit the original file) to some location such as the desktop or some other folder. Rename the file and change the file extension from *.GID to *.TXT. (If you have the file extensions hidden or are hiding hidden and extensions for known file types, double click MY COMPUTER, then click VIEW > OPTIONS > VIEW. Remove the check marks for hiding known extensions and select SHOW ALL FILES. If you did not see the *.GID files

ANSWER TO #3002 - MAR. 2000

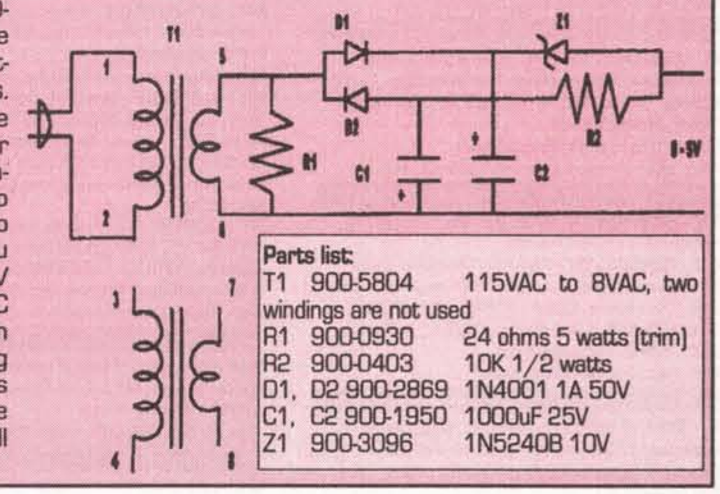
I need a circuit that when 150 volts AC is applied, the output would be +5 volts DC, and when the voltage goes down to 100 volts AC, the output would be 0 volts DC, and at 125 volts AC, it would be 2.5 volts DC.

The solution to your problem involves a transformer to bring the DC voltage down to 15V DC after rectification with 150-volts AC RMS input and a 10-volt zener diode to drop the voltage to five volts. Since the transformer provides a linear relationship of output to input, you should get 10V DC at 100V AC input which after dropping 10 volts through the zener diode, will give zero volts at the recorder.

Since the zener doesn't work well at low current, a negative voltage to maintain current through the zener is provided. If the output is too high, make R1 smaller and vice verse.

The parts are all from RadioShack.com.

Russell Kincaid
Milford, NH



Parts list:

T1	900-5804	115VAC to 8VAC, two windings are not used
R1	900-0930	24 ohms 5 watts (trim)
R2	900-0403	10K 1/2 watts
D1, D2	900-2869	1N4001 1A 50V
C1, C2	900-1950	1000uF 25V
Z1	900-3096	1N5240B 10V

before, you will now be able to see them.]

Using NOTEPAD, or similar text editor, open the file and look at its contents. Some of what you see will not make sense [ASCII control characters, etc.], other things, such as topic headings, will be quite obvious. You might have to select Word Wrap in your editor in order to see the contents properly. Scroll down toward the end of the file and you can see path information to various files.

Tim Naami
Poplar Grove, IL

ANSWER TO #3009 - MAR. 2000

I am a ham operator and have a receiver and transmitter.

My 600 ohm 1MW audio output is too low to drive my Collins phone patch. It needs at least 1 watt or 1.5 watts and requires 500 ohms.

I would like also to control the level out.

You can build a really nice booster with two ICs from Analog Devices. Use the SSM-2017 audio preamplifier to boost the output voltage.This part is especially nice since it is an instrumentation amp. Therefore, it requires only one resistor to set the gain which can be a pot.

Use this to drive the SSM-2141 balanced line driver. This device is designed to drive 600-ohm transmission lines at 10-volts RMS with ±18 volt supply rails so, it should have more than enough soup to drive your load.

Both parts are available through RadioShack.com Detailed information is available at analog.com including application schematics. You can also substitute parts from Burr-Brown which are available from Digi-Key.

Al Sekeet
Grand Rapids, MI

ANSWERS TO #3003 - MAR. 2000

How can I use the serial and parallel port to turn any load on?

Having several years experience on this particular topic, I can recommend two books:

For a general but practical understanding of how to use the ports, try *Build Your Own Low-Cost Data Acquisition And Display Devices*, by Jeffrey Hirst Johnson. [Tab Books, $22.00.]

For a very applications-oriented guide to [mainly] the parallel port, you could settle for *Controlling The World With Your PC*, by Paul Bergsman. [High Text Publications, $30.00.]

The first book teaches you more about how to use the ports, but the second book is easier to read.

Thomas Ng
San Jose, CA

ANSWERS TO #3003 - MAR. 2000

I would spend the $50.00 for a pre-made interface, such as Weeder www.weedtech.com digital I/O module, or *Nuts & Volts* March issue "More Bug Bytes" article on page 89.

If you are so inclined to build one yourself, use the parallel printer port. Search on Internet for "parallel port pinout" for a complete pinout of the connector.

Below is a simplified circuit using a 7404 Hex inverter and two 7475 Quad Latches. The key thing here is, when the PC puts its ASCII data on the printer bus, it's only there for one scan.

You must look for the STROBE and latch in the DATA BITS in order to preserve the 1s and 0s you need to turn things on and off. The strobe is opposite of the 7475 enable input, so invert using a 7404.

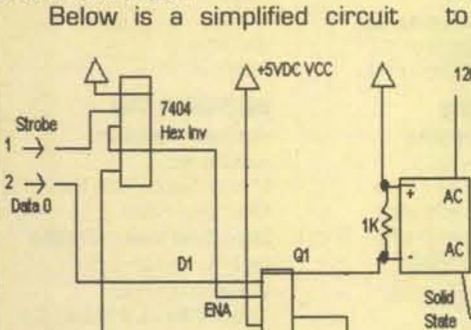
TTL is better at sinking [pulling to ground] than sourcing. Use a solid-state relay to turn on 120VAC loads because they are isolated and safer to use. Look for used relays, they are cheaper.

The latch output pulls down the [-] side of the relay input to turn it on. The latch provides a Q or NOT Q output, so you can make it normally closed or normally open.

Using QuickBasic or Visual Basic, send your data out using the print command: lprint "a"; puts the binary representation of ASCII "a" to the port.

Remember to use the semicolon after each lprint. If you don't, it will send a carriage return [ASCII 13], and this will screw up your desired result.

Search the Internet for ASCII to find your binary codes. You can also print by using: lprint chr$(0); will turn everything off, and lprint chr$(255); will turn all eight bits ON ... or any value between 0 and 255 to find the right combination of bits.



If you first turned on bit 1 using lprint chr$(1); and then you also want bit 2 turned on, if you lprint chr$(2); bit 1 will turn off and bit 2 will turn on. If you lprint chr$(3); bit 1 would stay on and bit 2 would also come on ...

You will need to do a little bit of binary logic stuff here.

Max Seim
Cottage Grove, MN

dealer directory dealer directory dealer directory dealer directory dealer directory dealer

DEALER DIRECTORY

The dealers listed below carry the latest issue of Nuts & Volts, for your convenience.

ALABAMA

Little Professor Book Center
2717 S. 18th St.
Birmingham 35209

RT Systems
Amateur Radio Supply
8207 Stephanie Dr.
Huntsville 35802

ARIZONA

Batteries Plus #330
3014 N. Dobson
Chandler 85224

Batteries Plus #334
1155 S. Power Rd. #108
Mesa 85206

Batteries Plus #331
2404 E. Bell Rd.
Phoenix 85032

Batteries Plus #332
3415 W. Glendale Ave. Ste. 4
Phoenix 85051

Batteries Plus #333
1829 E. Southern Ave.
Tempe 85282

Elliott Electronic Supply
1251 S. Tyndall Ave.
Tucson 85713

Power Quality, Inc.
642 E. 39th Pl. Ste. 5
Yuma 85365

Tower Records
3 E. 9th St.
Tempe 85281

AUSTRALIA

DonTronics
P.O. Box 595
29 Ellesmere Cres.
Tullamarine 3043
www.dontronics.com

CALIFORNIA

Abletronics
9155 Archibald Ave. Unit E
Cucamonga 91730

Advanced Computer Products, Inc.
1310 "B" E. Edinger Ave.
Santa Ana 92705

All Electronics
905 S. Vermont Ave.
Los Angeles 90006

14928 Oxnard St.
Van Nuys 91411

Alltronics
2300-D Zanker Rd.
San Jose 95131

Centerfold International
716 N. Fairfax Ave.
Los Angeles 90046

Del Amo Books & News
3758 Sepulveda Blvd.
Torrance 90505

Electro Mavin
2985 E. Harcourt St.
Rancho Dominguez 90221

Ford Electronics
8431 Commonwealth Ave.
Buena Park 90621

Harding Way News
113 W. Harding Way
Stockton 95204

Harold's Newsstand
524 Geary St.
San Francisco 94102

Hi-Fi Doctor
1814 E. Ball Rd.
Anaheim 92805

HSC Electronic Supply
4837 Amber Ln.
Sacramento 95841

3500 Ryder St.
Santa Clara 95051

5681 Redwood Dr.
Rohnert Park 94928

Hyatt Electronic Surplus
371 N. Johnson Ave.
El Cajon 92020

JK Electronics
6395 Westminster Ave.
Westminster 92683

Len's Electronic Parts
14410 E. Valley Blvd.
Industry 91746

Len's Electronic Parts
108 W. 25th St. #D
National City 91950

Lion Electronic Labs
4948 E. Townsend Ave.
Fresno 93727

Op Amp Technical Books
1033 N. Sycamore Ave.
Los Angeles 90038

Panorama Electronics
8761 Van Nuys Blvd.
Panorama City 91402

Sandy's Electronics Supply, Inc.
20655 Soledad Cyn. Rd. #15
Santa Clarita 91351

Sav-On Electronics
13225 Harbor Blvd.
Garden Grove 92643

Sierra Madre Newsstand
55 N. Baldwin Ave.
Sierra Madre 91024

The Red Barn
Hwy. 299
Bieber 96009

Tower Books
211 Main St.
Chico 95928

7840 Macy Plaza Dr.
Citrus Heights 95610

1280 E. Willow Pass Rd.
Concord 94520

630 San Antonio Rd.
Mountain View 94040

1600 Broadway
Sacramento 95818

2538 Watt Ave.
Sacramento 95821

Tower Records/Video
220 N. Beach Blvd.
Anaheim 92801

5703 Christie Ave.
Emeryville 94608

6310 E. Pacific Coast Hwy.
Long Beach 90803

3205 20th Ave.
San Francisco 94132

2525 Jones St.
San Francisco 94133

871 Blossom Hill Rd.
San Jose 95123

Video Electronics
3829 University Ave.
San Diego 92105

CANADA

Cody Books Ltd.
139-3000 Lougheed Hwy.
Westwood Mall
Port Coquitlam, BC V3B 1C5

Com-West Radio Systems Ltd.
8206 Ontario St. #100
Vancouver, BC V5X 3E3

Emma Marion Ltd.
2677 E. Hastings St.
Vancouver, BC V5K 1Z5

Muir Communications Ltd.
3214 Douglas St.
Victoria, BC V8Z 3K6

COLORADO

Centennial Electronics, Inc.
2324 E. Bijou
Colorado Springs 80909

Tower Records/Video
2500 E. 1st Ave.
Denver 80206

CONNECTICUT

Archway News
64 Bank St.
New Milford 06776

Electronic Service Products
437 Washington Ave.
North Haven 06473

DELAWARE

Newark Newsstand
70 E. Main St.
Newark 19711

DISTRICT OF COLUMBIA

Tower Records
2000 Pennsylvania Ave.
Washington 20006

FLORIDA

Alfa Electronic Supply
6444 Pembroke Rd.
Miramar 33023

Astro Too
6949 W. Nasa Blvd.
West Melbourne 32904

Clarks Out of Town News
303 S. Andrews Ave.
Fort Lauderdale 33301

Mike's Electronic Distributing Co.
1001 N.W. 52nd St.
Fort Lauderdale 33309

Skycraft Parts & Surplus, Inc.
2245 W. Fairbanks
Winter Park 32789

Sunny's At Sunset, Inc.
8260 Sunset Strip
Sunrise 33322

GEORGIA

Tower Records
3400 Around Lenox Dr. N.E.
Atlanta 30326

HAWAII

SolarWorks!
525 Lotus Blossom Ln.
Ocean View 96737

Tower Records
4211 Waialae Ave.
Honolulu 96816

611 Keeaumoku
Honolulu 96814

IDAHO

The Current Source
5159 Glenwood
Boise 83714

ILLINOIS

Tower Records/Video/Books
383 W. Army Trail Rd.
Bloomingdale 60108
2301 N. Clark St. #200
Chicago 60614

1209 E. Golf Rd.
Schaumburg 60173

INDIANA

Harbourtown Sales
108 Park 32 W. Dr.
Noblesville 46060

KANSAS

Hollywood At Home
9063 Metcalf Ave.
Overland Park 66212

Lloyd's Radio & Electronic, Inc.
220 W. Harry St.
Wichita 67213

LOUISIANA

Lakeside News
3323 Severn Ave.
Metairie 70002

MARYLAND

Tower Records/Video
2566 Solomons Island Rd.
Annapolis 21401

1601 Rockville Pike #210
Rockville 20852

MASSACHUSETTS

Newsbreak, Inc.
579 G.A.R. Hwy. Rt. 6
Swansea 02777

MICHIGAN

Little Professors Book Center
22174 Michigan Ave.
Dearborn 48124

Purchase Radio Supply, Inc.
327 E. Hoover Ave.
Ann Arbor 48104

MINNESOTA

Radio City, Inc.
2633 County Road 1
Mounds View 55112

MISSOURI

Accurate Instruments
11201 E. 24 Hwy.
Independence 64054

Electronics Exchange
8644 St. Charles Rock Rd.
St. Louis 63114

NEVADA

Amateur Electronic Supply
1072 N. Rancho Dr.
Las Vegas 89106

Less Buster's Electronics
2930 N. Las Vegas Blvd.
VSTG-22
North Las Vegas 89030

Radio World
1656 Nevada Hwy.
Boulder City 89005

Tower Records/Video
4580 W. Sahara Ave.
Las Vegas 89102

6450 S. Virginia
Reno 89511

NEW YORK

All Phase Video Security, Inc.
70 Cain Dr.
Brentwood 11717

Computer Warehouse
137 E. Bridge St.
Oswego 13126

Ham Central
3 Neptune Rd.
Poughkeepsie 12601

Hirsch Sales Corporation
219 California Dr.
Williamsville 14221

Tower Records/Video
105 Old Country Rd.
Carle Place 11514

350-370 Route 110
Huntington 11746

1961 Broadway
New York 10023

383 Lafayette St.
New York 10003

OHIO

Bank News
4025 Clark Ave.
Cleveland 44109

Compustuff
241 Great Oaks Trl.
Wadsworth 44281

Footsteps
4925 Jackman Rd. Store #58
Toledo 43613

Hosfelt Electronics, Inc.
2700 Sunset Blvd.
Steubenville 43952

Keyways, Inc.
204 S. 3rd St.
Miamisburg 45342

Leo's Book Shop
333 N. Superior St.
Toledo 43604

Powermaxx, Inc.
1587 U.S. Route 68 N.
Xenia 45385

OKLAHOMA

Steve's Books & Magazines
2612 S. Harvard
Tulsa 74114

Taylor News & Books
133 W. Main, Ste. 102
Oklahoma City 73102

OREGON

News & Smokes
2295 W. Main St.
Medford 97501

Norvac Electronics
7940 S.W. Nimbus Ave. Bldg. 8
Beaverton 97005

960 Conger
Eugene 97402

1545 N. Commercial N.E.
Salem 97303

Tower Books
1307 N.E. 102nd Ave.
Portland 97220

PENNSYLVANIA

Bedford St. News
308 Bedford St.
Johnstown 15901

Lehman Scientific
2997 F. Cape Horn Rd.
Red Lion 17356

Tower Books
425 South St.
Philadelphia 19147

Tower Records
340 W. Dekalb Pike
King of Prussia 19406

TENNESSEE

Tower Books
2404 W. End Ave.
Nashville 37203

TEXAS

BDL News, Inc.
809 Pierce
Houston 77002

Electronic Parts Outlet
3753-B Fondren Rd.
Houston 77063

Mouser Electronics
958 N. Main St.
Mansfield 76063

Tanner Electronics
1301 W. Beltline #105
Carrollton 75006

Tower Records
2403 Guadalupe St.
Austin 78705

VIRGINIA

Tower Records/Video/Books
4110 W. Ox Rd. #12124
Fairfax 22033
1601 Willow Lawn Dr.
Richmond 23230
8389 E. Leesburg Pike
Vienna 22182

WASHINGTON

A-B-C Communications, Inc.
17541 15th Ave. N.E.
Seattle 98155

Service Request
3304 W. Rowan Ave.
Spokane 99205

Supertronix
16550 W. Valley Hwy.
Seattle 98188

Tower Books
10635 N.E. 8th St.
Bellevue 98004

20 Mercer St.
Seattle 98109

WISCONSIN

Amateur Electronic Supply, Inc.
5710 W. Good Hope Rd.
Milwaukee 53223

Greenfield News & Hobby
6815 W. Layton Ave.
Greenfield 53220

Cudahy News & Hobby Ctr.
4758 Packard Ave.
Cudahy 53110

WYOMING

Western Test Systems
2701 Westland Ct. #B
Cheyenne 82001

RESCUE BEACON SYSTEM TO THE TEST

by Gordon West

The satellite emergency rescue beacons are known by a couple of different names, but their signals bring the same type of help. Pilots call them emergency locator transponders, "ELTs" for short. Hikers and on-foot explorers may call them personal locator beacons, or "PLBs" for short. Mariners call them emergency position indicating radio beacons, or "EPIRBs" for short.

The basic signal for these emergency beacons is 121.5 MHz, an aviation frequency for use as a civilian search and rescue channel. The 121.5 MHz distress system has been around for years, and well predates the use of satellites to detect an activated rescue beacon. For many decades, search and rescue aircraft have been outfitted with radio direction-finding equipment designed to home in on 121.5 MHz. In fact, the vast majority — if not all of the world's non-military search and rescue aircraft and vessels — are equipped with radio direction-finding equipment for homing in on 121.5 MHz.

"Sad to say, over 96 percent of 121.5 EPIRB activations from pilots, hikers, and boaters are accidental false activations," comments a search and rescue official at a local on-the-water beacon demonstration.

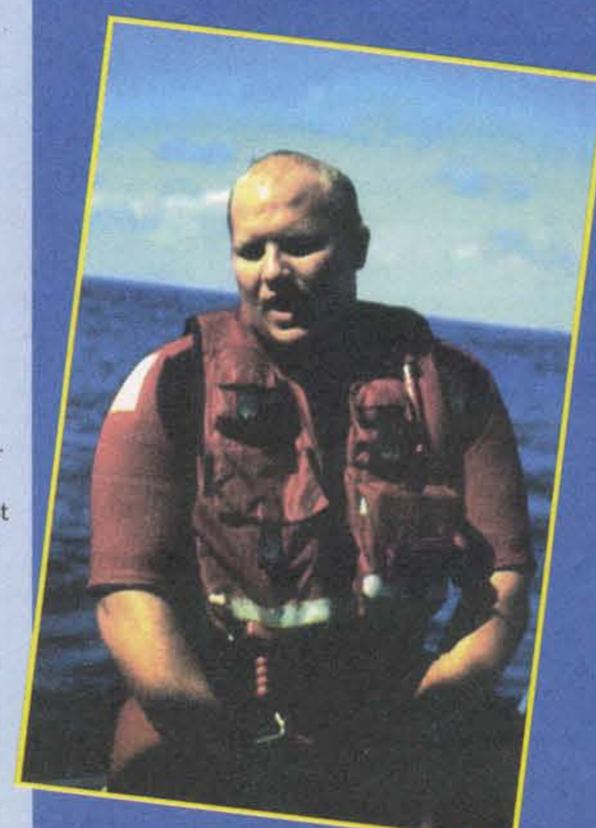
In the early 70's, a worldwide combined rescue organization called COSPAS-SARSAT launched satellite-aided tracking that worked relatively well for detecting 121.5 signals and, through Doppler shift analysis, land stations could approximate the location of an activated 121.5 MHz beacon. Doppler shift came from low-earth-orbit satellites in near polar orbit, traveling north to south and converging at the poles.

These satellites orbit the earth at relatively high rates of speed — essential for Doppler shift processing. The polar orbit, and the perpendicular rotation of the earth relative to their track, allows these satellites that routinely do weather observation duty to determine a 406 MHz emergency rescue beacon latitude and longitude by measuring the Doppler shift in frequency, and additional relative position checks by the signal strength.

But due to low-orbit altitude, their view of earth is limited, creating a potential delay in detection at just the 121.5 frequency. It would sometimes take up to six hours before rescue agencies had a sure-enough position to begin their search, and the location accuracy could be as much as 20 kilometers in diameter over a search of 1,260 kilometers squared.

A search mission in an airplane or helicopter, flying at 500 feet in good weather, can only observe approximately one-half mile on both sides of the flight path. With lower visibility and rougher terrain, the search width is even further reduced.

"Sad to say, over 96 percent of 121.5 EPIRB activations from pilots, hikers, and boaters are accidental false activations," comments a search and rescue official at a local on-the-water beacon demonstration. "So, it's no wonder that with such a high accidental activation, it sometimes takes many hours for officials to work out who is going to conduct the search effort, thinking in the back of their mind that here's another "budget buster" in manpower, aircraft, and other equipment to locate what could be just one more false alarm," adds the SAR representative.



By international agreement, a new signal is now added to modern emergency locator beacons — that signal at 406.025 MHz containing the emergency radio beacon's name, address, and other pertinent data that uploads to a geostationary set of satellites every 50 seconds. The data burst is at five watts output, as opposed to a half-watt for the 121.5 MHz signal. The data burst lasts approximately one second, and gives rescue personnel on land at a Mission Control Center (MCC) an immediate readout of the station doing the transmitting. The beacon with 406 MHz capabilities is pre-registered with the National Oceanic & Atmospheric Agency, and this information is right at the computer screen at Mission Control Center whose job it is to notify the appropriate rescue coordination centers based on the information they have.

The first job of the MCC when detecting an activated 406 MHz data burst is to look up the EPIRB information, and place a phone call to that listed phone number.

"We are picking up an activated EPIRB registered to you — do you have any idea where that EPIRB is?" is one question they'll ask. "Are they in an area that could necessitate an emergency call?" "Do you think

HH-65A "DOLPHIN" SHORT RANGE RECOVERY HELICOPTER

- Rotor Diameter: 39' 2"
- Height: 13'
- Length: 44' 5"
- Max Gross Weight: 9,200 pounds
- Empty Weight: 6,092 pounds
- Number of Engines: 2
- Fuel Capacity: 1,900 pounds
- Max Speed: 165 knots
- Cruising Speed: 120 knots
- Max Range: 300 nautical miles

this might be an accidental activation, or a real activation?" is another question they probably ask.

If the called party indicates that indeed their loved one is far out at sea, or way up in the Alps, or trudging across the tundra, the Mission Control Center will then go into action within minutes to notify the nearest rescue coordination center of the details.

The 406.025 MHz signal is detected by the new GEOSAR system. The beacon with a USA country code will be routed to the United States Mission Control Center, or NOAA. NOAA and USMCC then stand by for the low-earth-orbit satellites to locate the beacon on 121.5 MHz before forwarding the emergency to the closest appropriate rescue coordination center. The 121.5 MHz is still the frequency of choice for local radio direction-finding and homing, as well as low-earth-orbit position finding. The 121.5 MHz frequency works extremely well as a homing frequency, whereas the 406 MHz frequency is an extremely poor homing signal due to its less than half-second broadcast duration and 60-second broadcast interval.

With this in mind, the obvious answer to improve the overall rescue response was to embed a GPS-derived position into the 406.025 MHz uplink signal. And this is what is being done by new state-of-the-art 406 MHz EPIRBs with GPS upload capabilities. The 121.5 MHz half-watt locating signal is still continuously on, but more important is the new information showing GPS-derived latitude and longitude every 50 seconds.

Northern Airborne Technology (Marlborough, MA) incorporated the GPS receiver within the GPS equipment itself. They aptly named their equipment a "GPIRB" — a land or sea self-locating emergency beacon that may upload a GPS position accurate to 100 meters to the GEOSAR satellite that has a footprint that provides coverage from 70 degrees north to 70 degrees south latitudes, and east/west 75 degrees from their respective location. Currently, there are four satellites in the GEOSAR network, stationed at 75 degrees west, 135 degrees west, 74 degrees east, and 93.5 degrees east, producing better than 95 percent constant coverage of the temperate waters of the world.

When activated, the GPIRB from NAT locates itself and, after verifying acceptable parameters of position accuracy, loads its current position digitally into the transmission sentence for broadcast to the satellites on 406 MHz. It does hit every 20 minutes.

The GPIRB from NAT may improve rescue efforts in several other ways, along with the initial activation location. The rescue coordination center (RCC) can calculate drift, and can save considerable search time by dispatching rescuers toward a computed recovery point based on how long it may take them to get to the scene.

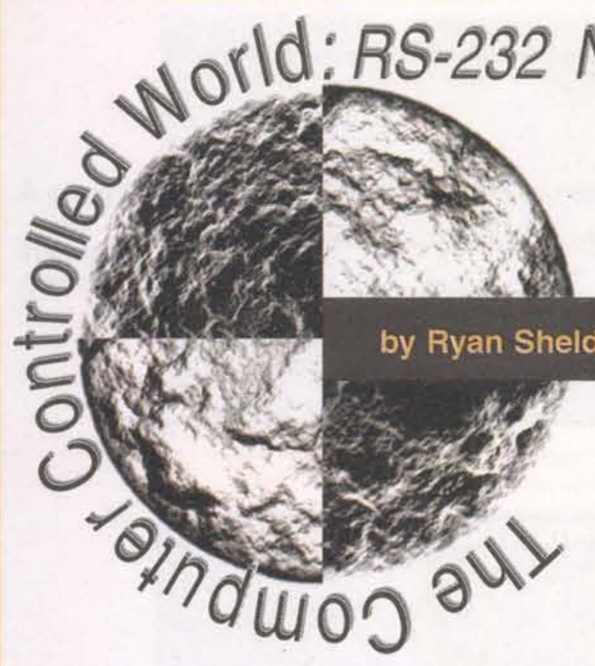
Another EPIRB with GPS interface for mariners is from well-respected EPIRB manufacturer ACR Electronics (Fort Lauderdale, FL). The automatic or manual deployable 406 MHz EPIRB is connected to a ship or land GPS with an infrared interface. The EPIRB is dramatically smaller in size than a similar EPIRB with the satellite receiver built in. The ACR EPIRB works with position information that is continuously updated and stored in the EPIRB every 20 minutes from the external GPS source.

When the EPIRB is taken out of its cradle, or automatically activates if a Category 1, it separates from the GPS datastream and begins sending the signal every 50 seconds on 406.025 MHz, and continuously sending a homing signal on 121.5 MHz. "We feel that this type of GPS connection is far superior to trying to receive a GPS signal within itself floating in the water," comments John Jones, Manager, ACR Product Line Government Contracts. "In heavy seas, it might be tough to receive a GPS position from a built-in receiver with water constantly flowing over the top of the unit," adds another ACR representative.

But George Lariviere at Northern Airborne Technology disagrees — "Our unit is far superior because it allows rescue agencies to determine drift and set every 20 minutes, and this will lead to a much faster position find."

Actually, both systems work extremely well because most rescue agencies will first fly to the location embedded in the 406 MHz EPIRB stream, and then switch on direction-finding equipment within their aircraft to home in on the floating or land-based signal. During recent sea trials in Miami, in cooperation with the United States Coast Guard and NOAA, it took only five minutes for the Mission Control Center to make that first phone call to find out what was going on with an activated beacon, and only 53 minutes for the United States Coast Guard's "Dolphin" — a short-range recovery helicopter — to fly overhead and deploy its rescue swimmer to our "victim" in the untethered life raft.

The 406 MHz signal with GPS information is far superior to anything else in the past, and to learn more about the new GPS EPIRBs for land, air, and sea, contact the following organizations: **Northern Airborne Technology**, 1-800-225-4767, and ask for George; and **ACR Electronics**, 954-981-3333, and ask for Paul Hardin, Vice-President, Marketing & Sales. **NV**



RS-232 Network Control Methods and Applications

Big Byte Bugs

by Ryan Sheldon, National Control Devices • (417) 646-5644 • www.controlanything.com

Discover seven new devices that offer even more capabilities.

If you have been following my articles in Nuts & Volts, then you have seen a number of new microprocessor-based devices that simplify your computer-controlled world. This month, I will introduce you to seven new devices that offer even more capabilities.

E3C

What you may or may not have picked up on is that some of our new devices are E3C-compliant. E3C is a standard that I developed that allows different types of devices to peacefully coexist on a single serial port. E3C stands for "Enabled 3-Wire Communication." Up to 256 different E3C-compliant devices may be connected to the same serial port, and individually or simultaneously controlled. Using E3C, it is possible to chain servo controllers, A/D converters, vacuum florescent displays, relay controllers, and digital I/O chips all on a single serial port.

When using an E3C-compliant device, the first thing you will need to do is give the device an E3C device number. On some devices, the device number must be burned into the processor prior to shipment. In other devices, a set of eight dip switches are used to set the device number. In some of our newer circuit board devices, the device number can be programmed into nonvolatile memory. A device number is simply a name in the form of a number from 0 to 255.

Controlling E3C Devices

Here's how it works. When you first power up your computer and all your devices, you can send commands out your serial port and all 256 devices will respond. Using the E3C command set, you can control which devices are active and inactive. You can tell several devices to listen to your commands, or you can send commands to one device at a time. The E3C command set consists of six commands, shown in Figure 1.

E3C command 252 is the one most commonly used. This command allows you to speak to a specific device. All other devices will ignore your commands. E3C-compliant devices have the slider shown in Figure 2 as part of the Visual Basic 6 programming examples.

Command	Parameter	Description
248	None	E3C: Enable All Devices
249	None	E3C: Disable All Devices
250	0-255	E3C: Enable Selected Device
251	0-255	E3C: Disable Selected Device
252	0-255	E3C: Enable Selected Device, Disable All Other Devices
253	0-255	E3C: Disable Selected Device, Enable All Other Devices

Figure 1: The E3C Command Set.

Figure 2: The E3C Device Selector Slider.

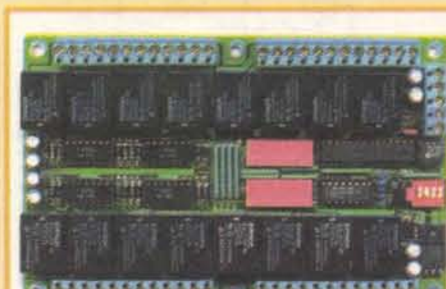


Figure 3: The R16 E3C-Compliant 16-Relay Controller.

Baud Rate	Clock Speed	DigiKey Part www.digikey.com
1200	500 KHz	X922-ND
2400	1000 KHz	X926-ND
4800	2 MHz	PX200-ND
9600	4 MHz	X902-ND
14.4K	6 MHz	X904-ND
19.2K	8 MHz	X905-ND
24K	10 MHz	X906-ND
28.8K	12 MHz	X907-ND
38.4K	16 MHz	X908-ND
48K	20 MHz	X909-ND

Figure 4: The baud rate is selected by the use of different ceramic resonators.

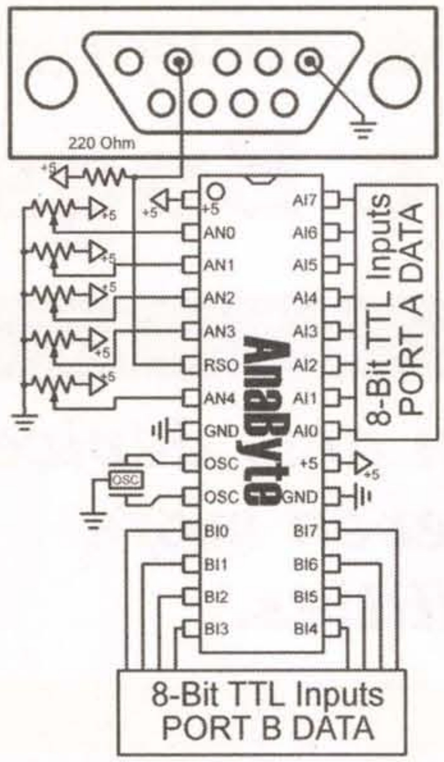


Figure 5: The AnaByte Parallel-to-Serial Encoder with Five A/D Inputs.

Figure 6: The AnaByte Monitor.

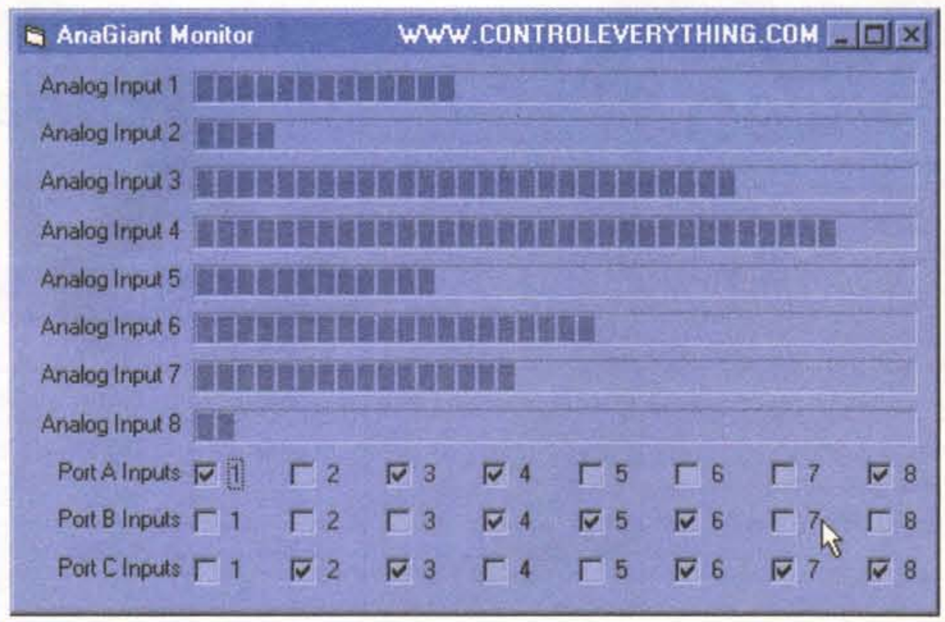


Figure 8. The AnaGiant Visual Basic Program.

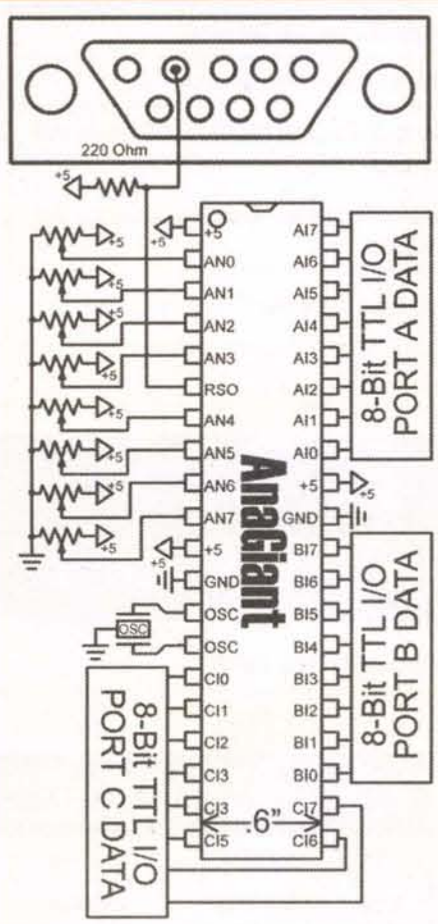


Figure 7: The AnaGiant Parallel-to-Serial Encoder with Eight A/D Inputs.

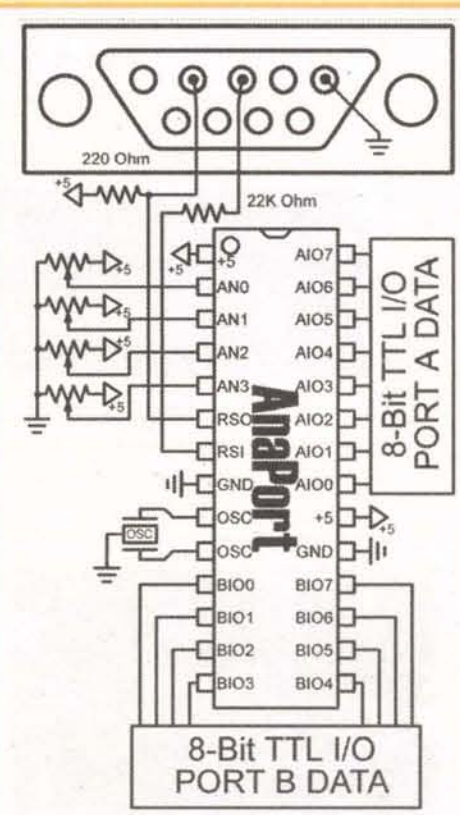


Figure 9: AnaPort E3C-Compliant Four-Channel A/D with 16 Programmable I/O Lines.

Figure 3 shows our new E3C-compliant 16-relay controller. Up to 256 of these boards can be attached to a single serial port, and controlled individually. But more importantly, this device can be mixed on a single serial port with other types of devices such as some chips in this article. Each can be individually controlled in any combination. So, if you need hundreds of analog and digital inputs, as well as the ability to control hundreds of relays, E3C-based devices will meet your needs for a long time to come.

Baud Rates

The chips outlined in this and previous articles can be controlled at several different baud rates. Baud rates are determined by the speed of the oscillator, denoted as OSC or CR1 in the diagrams. Some devices are limited to eight MHz (such as the eight-pin chips in this article). Figure 4 shows a table of resonators that can be used. All resonators are available from Digi-Key (www.digikey.com). The first two resonators listed require capacitors. Please read the Microchip (www.microchip.com) data sheets on PIC devices for selecting the appropriate capacitors for your design.

Non-E3C Devices

Some devices in this article are NOT E3C-compliant. They serve a small niche of people who need a quick and cheap solution to a problem, but may never need to expand. Non E3C-compliant devices are a little easier to work with, since they do not require any commands from a computer to tell them what to do.

AnaByte

Figure 5 shows the AnaByte — a 16-bit parallel-to-serial encoder with five analog-to-digital converters. The AnaByte constantly transmits packets of data consisting of eight bytes. The baud rate is determined by the oscillator used on the OSC lines (see Fgure 4 for details).

Figure 6 shows a simple Visual Basic 6 pro-

gram that reads packets of data generated by the AnaByte chip. These data are then used to adjust the five level meters and set the status of the 16 check boxes. The AnaByte is not an E3C-compliant device, so only one chip may be connected to a single RS-232 serial port. While easy to use, it is not expandable.

AnaGiant

Figure 7 shows the AnaGiant — a 24-bit parallel-to-serial encoder with eight analog-to-digital converters. The AnaGiant constantly transmits packets of data consisting of 13 bytes. The baud rate is determined by the oscillator used on the OSC lines (see Figure 4 for details).

Figure 8 shows a simple Visual Basic 6 program that reads packets of data generated by the AnaGiant chip. These data are then used to adjust the eight level meters and set the status of 24 check boxes. The AnaGiant is not an E3C-compliant device, so only one chip may be connected to a single RS-232 serial port.

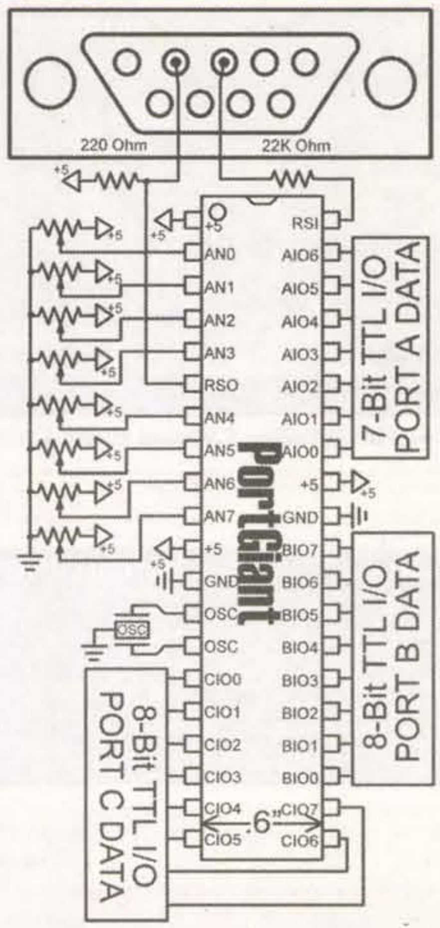


Figure 11: PortGiant E3C-Compliant Eight-Channel A/D with 23 Programmable I/O Lines.

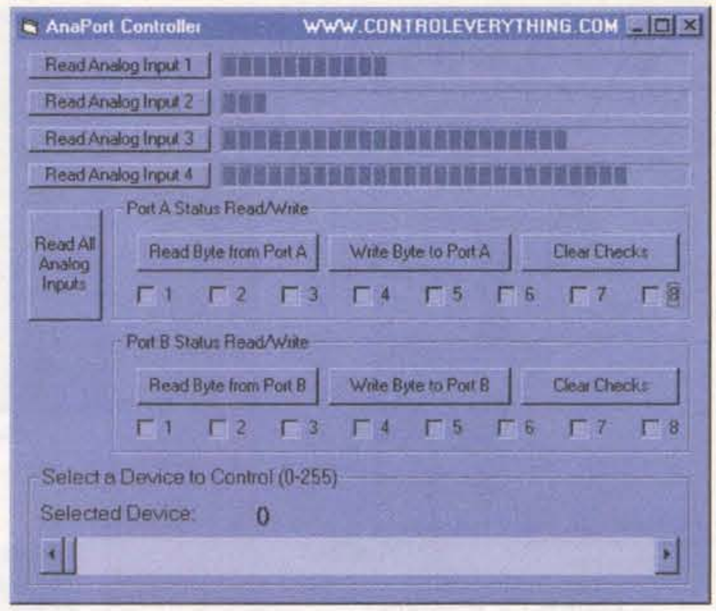


Figure 10: The AnaPort Visual Basic Controller Program.

AnaPort

AnaPort (shown in Figure 9) supports two-way communication between the host computer and allows you to read the A/D value on any (or all) analog inputs. In addition, the AnaPort has 16 programmable I/O lines. Under software control, you can read or write bytes to each of the two ports. The AnaPort is E3C-compliant, allowing 256 different devices to share a single serial port. The device number is programmed into the chip at the time of purchase.

Figure 10 illustrates a simple Visual Basic 6 program used to control the AnaPort chip. A slider is provided, allowing you to select which device to control. Other buttons allow you to read analog inputs (individually or simultaneously) and control the reading and writing of data to the two data ports.

PortGiant

PortGiant is shown in Figure 11. PortGiant is nearly identical to the AnaPort, except that it offers more analog inputs and more programmable I/O data lines. Figure 12 illustrates a simple Visual Basic 6 program used to control the PortGiant chip. Again, the device number is programmed into the chip at the time of purchase.

BitaBug3

The BitaBug3 provides three programmable TTL outputs from an RS-232 data input. The BitaBug3 supports the E3C command set, allowing up to 256 different devices to share a single serial port. The BitaBug3 also supports commands for controlling each output individually, as well as all outputs simultaneously. The BitaBug3 includes a four-MHz ceramic resonator for communication at 9600 baud.

Figure 14 illustrates a simple Visual Basic program used to control each of the three outputs. The E3C slider is used to select a device to control.

Key3

If you ever needed the ability to monitor a few buttons from a serial port, the Key3 chip may be exactly what you are looking for. When a button is pressed, an ASCII character code from 0 to 7 is transmitted to your computer. The Key3 chip is combinational, allowing you to simultaneously press buttons for different output codes. Figure 16 shows a list of key-press combinations.

The Key3 Button Monitor program decodes the data generated by the Key3 chip, displaying which buttons have been pressed.

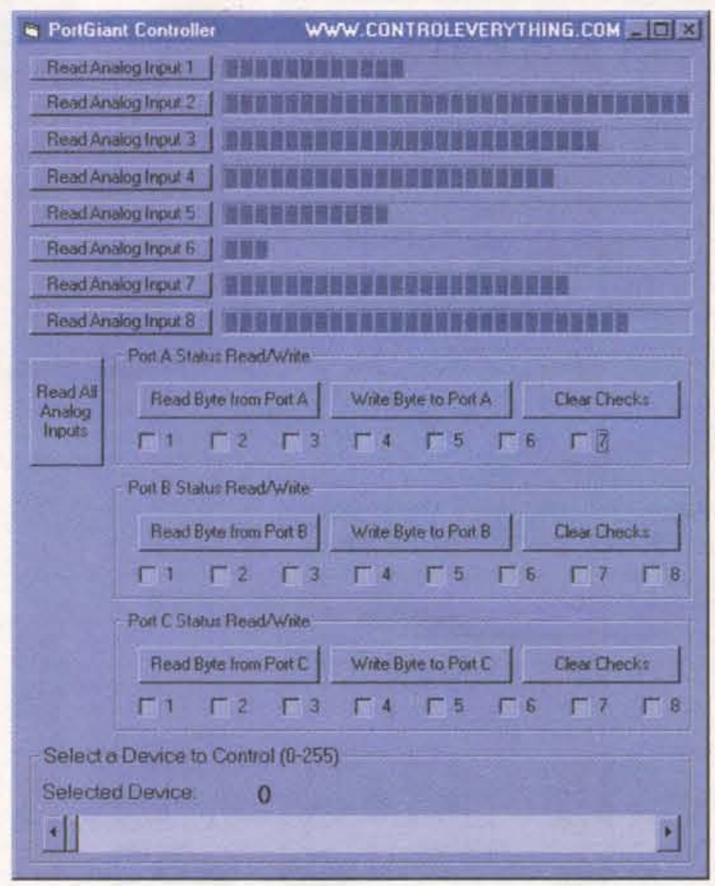


Figure 12: The PortGiant Visual Basic Controller Program.

JoyScam

Several readers have wanted to control servos using a joystick. The JoyScam chip was designed to accomplish this task by generating data packets that can be interpreted by the SCAM chip. The JoyScam connects to two potentiometers: one for vertical and one for horizontal. As the joystick is moved, SCAM-compatible data packets are generated for positioning two servos.

The JoyScam chip can share a serial port with the computer as shown in Figure 17. The computer can be used to select which SCAM chip to control. The user interface shown in Figure 18 is also capable of positioning the servo motors.

The JoyScam chip also has a logic level input that is mirrored by the logic level output on the SCAM chip. The JoyScam chip is NOT compatible with the SCAM2 chip and should only be used with the original SCAM chip. Figure 18 shows a simple Visual Basic 6 program for controlling the SCAM chip, as well as the E3C device slider for controlling which device receives the data packets from the JoyScam chip. Either the Visual Basic 6 application or the JoyScam chip can be used to position the servos.

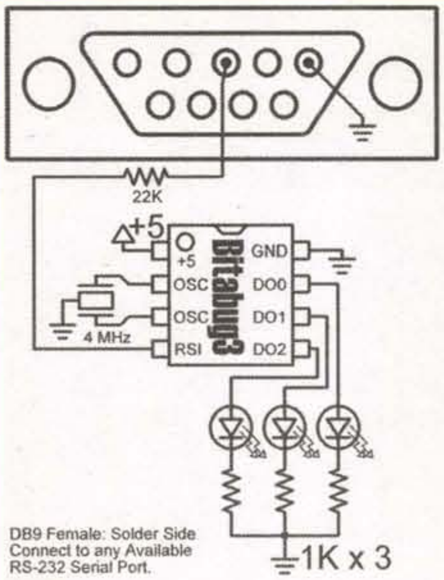


Figure 13: BitaBug3 E3C-Compliant Three-Bit Serial-to-Parallel Converter.

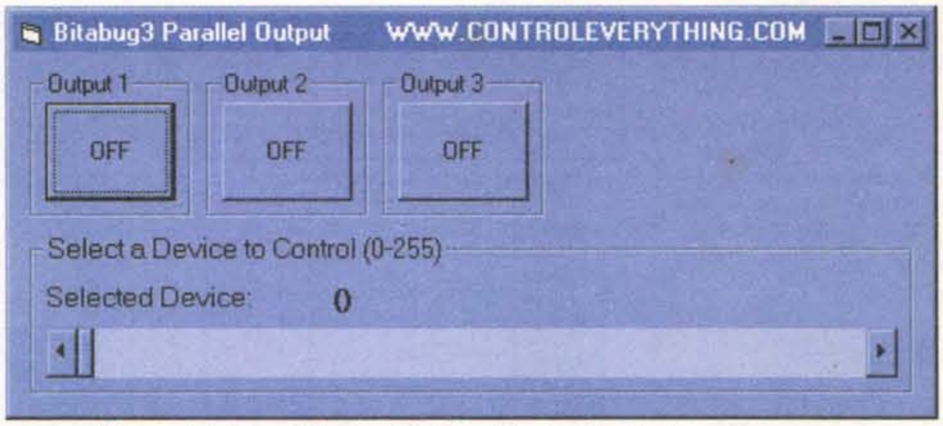


Figure 14: The BitaBug3 Visual Basic Controller Program.

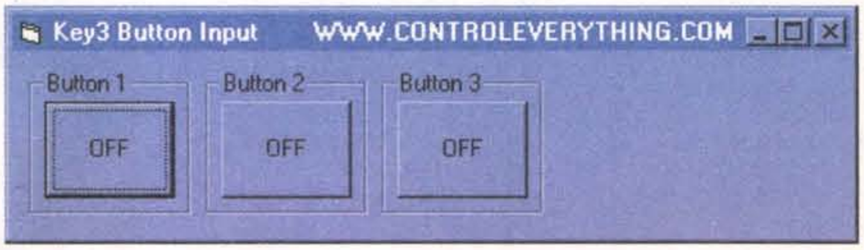


Figure 16: The Key3 Button Monitor Program for Visual Basic 6.

Button 1	*Button 2*	*Button 3*	*ASCII Output*
Pressed			0
	Pressed		1
Pressed	Pressed		2
		Pressed	3
Pressed		Pressed	4
	Pressed	Pressed	5
Pressed	Pressed	Pressed	6

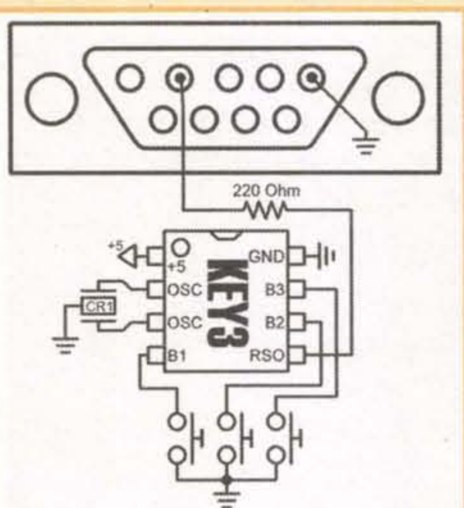


Figure 15: The Key3 Three-Button Encoder with RS-232 Output.

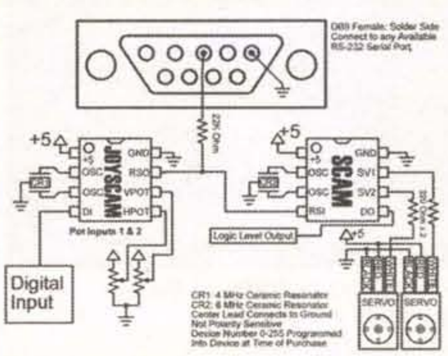


Figure 17: JoyScam Joystick Controller for the SCAM Chip.

Figure 18: The SCAM Controller Program for Visual Basic 6.

Software and Data Sheets

A few people have reported that they cannot find the software or data sheets for these chips. Both data sheets and software can be found at www.controleverything.com. Select the "Products" link, then select the "Microcontrollers" link. Download the Visual Basic 6 source code "Bugs.ZIP." The programs found in this archive are easily translated to other programming languages. The data sheets can also be found on this page. Select "Download Data Sheets" in red, linked several times on this page. More detailed information on all available CPUs can be found in the data sheets.

Availability

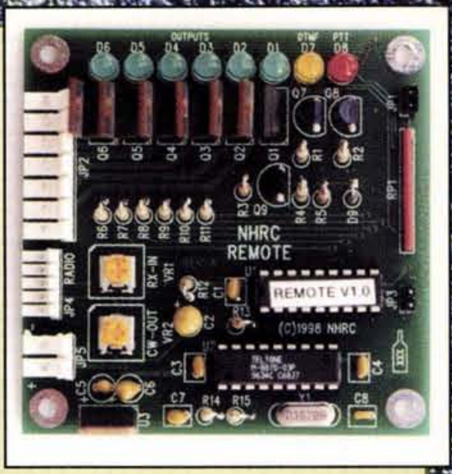
The microprocessors in this article were in development at the time of writing and should be available by the time you read this. The latest pricing and availability information can be found at www.controleverything.com. Select "Products," then "Microcontrollers." Pricing is located in the data sheets. These devices can be ordered by following the "Ordering" link from the main page.

I hope you enjoyed this month's "Computer-Controlled World." As usual, feel free to E-Mail or call with any questions you may have. **NV**

CONTACT INFO:
Ryan Sheldon
National Control Devices
P.O. Box 455
Osceola, MO 64776
Phone: (417) 646-5644
FAX: (417) 646-8302
ncdryan@aol.com
www.controlanything.com

New Product News

NHRC-INTELLIGENT REMOTE CONTROLLER



NHRC LLC announces the introduction and availability of the NHRC-Intelligent Remote Controller.

The NHRC remote is a low-cost DTMF remote controller that allows the remote control of six loads by sending DTMF commands over any audio circuit. The remote is based on the Microchip 16f84 microcontroller and the Teltone M8870 DTMF decoder IC. The remote can be connected to almost any audio source, receiver, or transceiver without the need to go inside the radio for any signals. Since the remote works from any audio source, it does not require any modifications or exploration into a radio.

The NHRC remote has the ability to send command confirmation messages via Morse code that can be sent over any audio circuit. This makes the device useful for radio or wireline applications. For radio applications, the NHRC remote can send a Morse code ID message a predefined amount of time after first transmitting.

The compact, 3 x 3" size allows it to be embedded inside a repeater or other project.

The NHRC remote is available for $89.00. NHRC has several other lines of repeater controllers starting from $169.00 – including the brand new NHRC-10 Advanced Repeater Controller – which utilizes the newest technology available to provide maximum functionality with the fewest parts.

For more information, contact:

NHRC LLC
444 MICOL RD., DEPT. NV
PEMBROKE, NH 03275
603-485-2248
E-MAIL: info@nhrc.net
WEB: www.nhrc.net

WR-700 WEATHER RESISTANT CAMERAS

Matco releases the WR-700 Weather Resistant Cameras.

The WR-700 Weather Resistant Cameras provide protection from rain, snow, and sleet. They are ideal for outdoor applications.

The camera has a 1/3" interline CCD image sensor with no audio. It has a high resolution of 430 TV lines, 0.1 Lux for the B/W model, and 400 TV lines, 2 Lux for the color model. With the special moveable shroud, the camera can reduce glare in direct sunlight.

The camera requires 12 VDC power supply. The camera is 3-1/2" x 2-1/3" x 2-1/3" in dimensions. Mounting hardware is included in the packet.

For introductory sales, dealer pricing for the B/W WR-700 Weather Resistant Cameras is $89.00 each and for the color WR-700-C Weather Resistant Cameras is $179.00 each.

For more information, contact:

MATCO, INC.
830 E. HIGGINS RD., #111-G, DEPT. NV
SCHAUMBURG, IL 60173
847-605-1020
FAX: 847-619-0852
1-800-719-9605
E-MAIL: press@mat-co.com
WEB: http://www.mat-co.com

INDUSTRY-STANDARD I2C PC CARD NOW IN PCI FORMAT

Saelig Company announces PCI90 – the only available PCI-format I2C-bus communications adapter.

Made in Europe, this new board complements Calibre UK's existing industry-standard range of ISA format I2C bus adapters (ICA90/93).

I2C is a two-wire bus that is widely used in Calibre's new PCI-to-I2C adapter television and audio systems, power supplies, and other systems to keep cable connections to a minimum.

I2C is now also being used for PC and server networking in Intel's IPMI implementation. PCI90 allows PC users to easily gain control of I2C systems in test, development, and manufacturing situations using self-configuring PCI slots.

PCI90 supports single and multi-master I2C operations and can also be programmed as a slave device.

32-bit Windows DLLs are included, giving users an easy software development path without requiring specialist PCI or Windows I/O knowledge.

For new I2C users wanting a quick start with the bus, ready-to-run WINI2CPCI Windows 95/98/NT software provides all the common I2C functions and also includes a unique real-time I2C bus monitor/datalogger for investigating bus activity.

PCI90 provides an easily-installed, cost-effective solution to I2C bus communications for software or hardware developers or test engineers.

PCI90 is available from stock at $399.00.

For further information, contact:

SAELIG COMPANY LLC
1193 MOSELEY RD., DEPT. NV
VICTOR, NY 14564
716-425-3753 FAX: 716-425-3835
E-MAIL: saelig@aol.com
WEB: www.saelig.com

EN-808 OUTDOOR HOUSING FOR BOARD CAMERAS

Matco releases the EN-808 outdoor housing for board cameras.

The EN-808 is one of the industry's smallest, most stylish, lowest profile cameras. It has aluminum construction with a lexan window. Dimensions are 3" x 3-3/4 footprints by 2-1/2" H.

The EN-808 camera can mount anywhere, ceiling or wall. With the unique design of weather resistant outdoor housing, the EN-808 provides protection from rain, snow, and sleet. It's ideally suited for outdoor surveillance applications.

The EN-808 camera includes an indoor camera housing which fits a B/W or color camera. Both B/W and color cameras are available from Matco.

As a special introductory offer, dealer pricing of the EN-808 is $15.00 each for a limited time.

For more information, contact:

MATCO, INC.
830 E. HIGGINS RD., #111-G, DEPT. NV
SCHAUMBURG, IL 60173
847-605-1020 FAX: 847-619-0852
1-800-719-9605
E-MAIL: press@mat-co.com
WEB: http://www.mat-co.com

Showcase your New Products here! Send all press releases or information/photos to:

Nuts & Volts Magazine
New Product News
430 Princeland Court,
Corona, CA 92879
or E-Mail to
newproducts@nutsvolts.com

High Performance Auto Ranging DMM

New to our DMM line-up and possibly (probably) the best DMM value anywhere! Includes: Analog Bar Graph! Auto-Ranging! Data Hold! Temperature Probe! Frequency Test! Continuity Test! AND MORE!

NOW IN STOCK! ONLY $29.95

Features

Data Hold: Freezes reading for easy checking
Auto Ranging: For easy, precise range settings
Range Hold Control: allows for manual selection of your test range
3-3/4 Digit LCD Display: Reads up to 3260. Easy to read display.
Function Dial: Easy to use to select measurement type or turn unit off.
4 Jack Plug-ins: Safety design with different capacities for different functions.
Diode, Continuity Check Push-Button: For toggling between diode check and continuity check.
Low Battery Indicator: Advises you when it's time to change battery.
Extra Long 44" Test Leads: Helps get to hard to reach places
Screw-On Alligator Clips: Convert one or both probe tips to alligator clips.
Fuse-Protected Circuitry
Built-In Stand: Makes one hand operation easier.
Shock Absorbing Rubber Carrying Case: with convenient probe storage clips and hanging tab. Helps protect the DMM from damage if accidentally dropped.

Measures:

DC Volts: up to 1000V
AC Volts: up to 750V
AMPS: up to 20 Amps (AC & DC)
Resistance: up to 30M ohm
Continuity Check: with audible signal (signal sounds if resistance is less than 20 ohms. Display reads actual resistance).
Frequency: (1KHz to 300KHz) displays both digital and bar graph reading
Transistor hfe Test: Display shows approximate hfe value based on test condition of 10uA base current and Vce of approx. 3V.
Temperature Test: Measures from 0° to 1832° F (probe supplied!)
Diode Test: Tests if diodes are shorted or open

Specifications

Accuracy

Vdc:	±1.0% reading +5 ditis
Vac:	±1.5% reading +8 digits
Adc:	±1.2% reading +5 digits
Aac:	±1.5% reading +5 digits
Resistance:	±1.5% reading +5 digits
Frequency:	±3.0% reading +5 digits
Temperature:	±1.0% reading +6 digits

#CSI9903

Input Impedance: 10Mohm (Vdc/Vac): over 100Mohm on 300 mVdc range
Requires two AAA batteries sold separately.

2GHz RF Field Strength Analyzer

ONLY $1589

- Frequency Range: 100KHz to 2,060MHz
- Narrow Band FM (NFM), Wide Band FM (WFM), AM and Single Side Band (SSB) Modulated Signals May Be Measured
- PLL Tuning System for Precise Frequency Measurement and Tuning
- LED Backlight LCD (192x192 dots)
- Built-In Frequency Counter
- Hand-Held and Battery Operated
- All Functions are Menu Selected
- RS232C for PC Interface and Printer

#3201

See the web site for details

Removable Hard Drive Rack

For IDE/Ultra DMA Hard Drives

We Sold Over 14,000 in 1998!

ONLY $14.95 any qty.

This product can be used with any 3-1/2 IDE hard drive up to 1" high. It includes an electronic keylock for safe removal and insertion. Made of ABS 707 fireproof plastic. Use this product to protect sensitive hard drive data, take your hard drive between work and home or even set up different users with their own hard drives that they physically insert every time they use a PC. Other models available from C.S.I. include RH10 series and RH20 series, which are interchangeable within the same interface design (IDE or SCSI).

RH-10C-IDE

Other Models are Available. *See www.web-tronics.com under "hard drive and accessories" for more details and pictures.*

Removable Hard Drive Rack with Auto Door And Cooling Fan

ONLY $18.95 any qty.

- Auto door on the outer frame
- ABS material of outer frame, High efficiency cooling fan
- Worldwide patent pulling function handle
- CE Approved
- Coating iron bottom cover
- For IDE interface
- For 1" high 3.5" HDD
- Not compatible with our RH10 & RH20 series. Compatible with our RH17-IDE model.

#MR-27

Details at www.web-tronics.com

Auto-Temp Solder Station with Ceramic Element

ONLY $39

- With Ceramic Heating Element for More Accurate Temp Adjustment
- 3 Conductor Grounded Power Cord
- 250°C-480°C (470°F-900°F)
- Fast Heating Feature

SR-976

Extra Tip Options Available. See Web!

For More Info See www.web-tronics.com

CTRL - D to bookmark this site

www.web-tronics.com

Don't forget the dash

- Easy to Navigate
- Includes a Search Engine That Really Works
- New Items Added Constantly

Circuit Specialists Inc.

In Business Since 1971

CCD B&W Board Cameras

- ***ASIC CCD Area Image Sensor***
- ***Extremely Low Power Consumption***
- ***0.5 Lux Min Illumination***
- ***Built-In Electronic Auto Iris for Auto Light Compensation***

Detailed Specs on the Web

LOWER PRICES

VM1030PA-B 30mmx30mmx25mm, Pinhole lens, 12V $39.00 any qty.
VM1030A 30mmx30mmx26mm, Standard lens, 12V $39.00 any qty.
VM1035A 42mmx42mmx25mm, Standard lens, 12V with back light compensation $49.00 any qty.
VMCB21 44mmx38.5mmx28mm, with 6 infra-red LEDs, 12V $49.00 any qty.
VM1036A 32mmx32mmx25mm, Standard lens, 12V, reverse mirror image feature $49.00 any qty.

Mini CCDs (B/W & Color)

Sensational NEW Design for Small Observation Cameras. *Smaller and Better!*

LOWER PRICES

- ***Ultra Miniature Design***
- ***Black & White Versions Only 25mm x 25mm***
- ***Color Versions Only 32mm x 32mm***
- ***Available in Standard Lens or Pinhole Lens***
- ***All Include Pre-Wired Cable Harness for Video & Power***
- ***12V Regulated Power Supply Required (120mA typical power consumption)***
- ***0.1 LUX Rating (B/W), 1 LUX (color)***
- ***CCD Area Image Sensor for Long Camera Life***
- ***Back Light Compensation Circuit***
- ***Built-In Electronic Auto Iris Lens***

Detailed Specs on the Web

VMCW-H11A 32mmx32mmx30mm, Color CCD with standard lens, pre-wired cabling, 12V DC Power $139.00 / $129.00 5 or more
VMCW-H12A 32mmx32mmx19mm, Color CCD with pinhole lens, pre-wired cabling 12V DC Power Input $139.00 / $129.00 5 or more
VMPS-718A 25mmx25mmx30mm, B/W CCD with standard lens, pre-wired cabling, 12V DC Power Input $59.00 / $49.00 5 or more
VMPS-250A 25mmx25mmx15mm, B/W CCD with pinhole lens, pre-wired cabling, 12V DC Power Input $59.00 / $49.00 5 or more

Bullet CCD Cameras

B&W and Color

Detailed Specs on the Web

LOWER PRICES

- ***Smart Rugged Metal Housing***
- ***Extrememly Low Power Consumption***
- ***12 Volt***
- ***CCD Area Image Sensor for Long Camera Life***
- ***Built-In Electronic Auto Iris for Auto Light Compensation***
- ***No Blooming, No Burning***
- ***0.1 Min Lux Illumination (B&W), 1 Lux Min Lux Illumination (color)***

VMBLT1020 B&W, 21mm(D)x55mm(L) $49.00 any qty.
VMBLT1020W B&W Weatherproof, 21mm(D)x58.5mm(L) $79.00 any qty.
VMBLTJC19BW COLOR! Weatherproof, 17mm(D)x88mm(L) $139.00 any qty.

Hot Air SMD Rework Station

new!

WOW! ONLY $489

Similar Systems Cost 100s More!

ONLY $489

#SR-979

For technicians, service/repair depots and assembly rework. We also stock a selection of nozzles for QFP, SOP & PLCC devices (see our website for selection details). Hot Air temperature variable from 100°C to 400°C (212°F to 754°F) power consumption: 275w max. Auto cooling feature cools system after shut off to extend service life of heating elements and handle. One year limited warranty from C.S.I.
Comes with QFP Nozzle (0.68" x 0.68")

O'Scope Offer

new!

30MHz! ONLY $289!

ONLY $289

Take Advantage of this low introductory price!

- *Dual Channel*
- *Dual Trace*
- *Vert Trigger*
- *1 Year C.S.I. Warranty!*

#OSC-1030

Manufactured for CSI by a leading O.E.M. manufacturer. See our website for detailed specifications!

COLOR CCD Mini Board Cameras

PRICE REDUCTION

- ***Low Power Consumption***
- ***1 Lux Illumination***
- ***Built-In Electronic Auto Iris for Auto Light Compensation***
- ***Internal Synchronization***
- ***12Volts***
- ***400 TV Lines***

Detailed Specs on the Web

VM3010PA 33mmx33mmx18mm, Pinhole lens $99.00 any qty.
VM3011-A 45mmx40mmx24mm, Standard lens, single board $89.00 any qty.
VM3010-A 33mmx33mmx32mm, Standard lens $99.00 any qty.

2.4 GHz A/V Sender/ Receiver System

new!

- **Wireless FM transmission of video (color or B/W) and sound (stereo or mono) up to 150 meters (line of sight)**
- **Directional Antenna Design optimizes performance**
- **Use with remote cameras or any input (satellite TV, cable etc.) where wireless transmission is desired. View on a TV set.**
- **Performance through walls varies depending on construction methods etc.**
- **Each set includes a plug-in power supply for the transmitter & receiver.**
- **7 segment LED displays channel (1-4) on receiver & transmitter.**

IN STOCK! Order Now

CSIHTR2400 *Includes One Transmitter & One Receiver with Power Supplies* **$139.00**
CSIHTR2400TX *Extra Transmitter/Each Receiver will Monitor up to 4 Transmitters* **$89.00**

See more detailed specifications at www.web-tronics.com in the CCD camera setcion.

3-1/2 Digit JUMBO Digital Panel Meters *Check these LOW PRICES!*

new!

NOW IN STOCK!

AS LOW AS $6.25

- 21mm Figure Height
- 5Volt Common Ground or 9V Independent Power Supply Versions Available
- Voltage Divider Resistors included and max. Measured Range Selectable by Soldering a Selection Joint
- Easy Bezel Snap-In Design (84mm x 41mm rectangular hole typical)
- "0" Reading for "0" Voltage Input
- High Quality SMD Production Method
- Dual Slope Integration A-D Converter System ±0.5% Accuracy

PM-1028A *LCD* **9V Independent Power Supply Version 1/$12.95 10/$10.89 100/$7.99 250/$6.25**
PM-1028B *LCD* **5V Common Ground Power Supply Version 1/$13.95 10/$11.84 100/$8.89 250/$7.15**
PM-1029A *LED* **9V Independent Power Supply Version 1/$14.95 10/$12.50 100/$9.95 250/$7.89**
PM-1029B *LED* **5V Common Ground Power Supply Version 1/$15.95 10/$13.40 100/$10.79 250/$8.65**

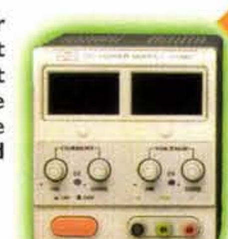
3000 Series Digital R/O Bench Power Supplies

♦*Low Cost Single Output*

AS LOW AS $89

High stability digital read-out bench power supplies featuring constant voltage and current outputs. Short-circuit protection and current limiting protection is provided. Highly accurate LED accuracy and stable line regulation make the 3000 series the perfect choice for lab and educational use.

Line Regulation: 2×10^{-4} +1ma
LED Accuracy: Voltage ±1% +2 digits
Current ±1.5% +2 digits
Wave Line Noise: ≤1mvrms
Dimensions: 291mm x 158mm x 136mm



CSI3003: 0-30v/0-3amp Digital R/O Bench PS, 1×10^{-4}+5mv Load Regulation
$99.00 5/$89.00

Our Most Sophisticated DMM *We Sold Over 700 Last Year!*

with RS-232 Interface & Software, 3-3/4 Digit, 4000 Count, Auto-Ranging with Analog Bargraph

- True RMS Mode
- 10MHz Frequency Counter
- Time Mode with Alarm, Clock, and Stop Watch
- Dual Display
- 10 Location Memory
- Min, Max, Avg and Relative Mode
- Decibel Measurement
- Cap and Ind. Measurement
- Temperature Mode (C/F)
- K Type Temperature Probe Included
- Pulse Signal for Logic & Audible Test
- Continuity/Diode Test
- Logic Test
- Auto Power OFF/"Keep ON" Mode
- Fused 20A Input with Warning Beeper
- Back Light
- Data Hold/Run Mode
- Safety Design UL1244 & VDE-0411
- Protective Holster
- Silicon Test Leads

NOW ONLY $129 *Reg. $169*

More Details on our Web Site

PROTEK 506

CIRCUIT SPECIALISTS, INC. 220 S. Country Club Dr., Mesa, AZ 85210 800-528-1417/480-464-2485/FAX: 480-464-5824

Write In 74 on Reader Service Card.

NUTS & VOLTS MAGAZINE
430 PRINCELAND COURT
CORONA, CA 92879-1300

[redacted]